DEVOTED EXCLUSIVELY TO METALLIC SURFACE TREATMENTS

METAL FINISHING

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by Palmer H. Langdon, 1868-1935

APRIL, 1948 VOLUME 46 • NUMBER 4

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COMING SOON

One of the most modern and complete research laboratories for plating and finishing studies is described and illustrated.

A new method for measuring the thickness of anodized coatings on aluminum alloys.

An article on the use of motor generators as power sources for plating.

Results of a state hygiene department study on the effectiveness of mist-suppressors in chrome plating baths.

Electropolishing of stainless steel parts on a production basis.

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ESTABLISHED 1903

DEVOTED EXCLUSIVELY TO METALLIC SURFACE TREATMENTS

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Contents Noted

The article on Anodes in this month's issue is a continuation of the series first presented in March, and gives helpful and authoritative information on the selection and maintenance of anodes for Gold, Zinc, Cadmium, Tin, Lead, and Chrome plating. Very little has been previously published on this all-important phase of plating operations, and the present article helps to clear up many of the vague and time-worn ideas on the subect.

While it is a little off the established path for technical magazines, we have included a very timely article on "hidden costs", and how they may be controlled to help meet the ever-increasing pressure for lower finishing costs. This topic is one which is of vital interest to both the large and small shop, and shows how an intelligent approach to labor relations by management and workers can insure the continued success of an enterprise. This discussion should prove equally valuable to workers and supervision.

Electropolishing is one of the most rapidly moving phases of the finishing field at the present time because it offers the possibility of reduced costs. Unfortunately, however, its limitations are not always considered along with its advantages. An article on the practical aspects of this method of surface preparation, with a discussion of the economic angle, is included in this month's issue.

How one of the largest manufacturing concerns in the country has managed to put their barrel finishing operations, such as burring, tumbling, and burnishing, on a soundly engineered basis is covered in another of this month's featured articles. Rarely has this oldest of finishing methods been so carefully planned as it has at this firm, and the resulting savings have proven that with careful study even this method, one of the most economical in the entire field, can be made to affect important savings. This is mass-production barrel finishing at its highest efficiency, and offers a good example for others who use this technique.

Having thoroughly discussed the construction, operation, and advantages of rectifiers as power sources for electroplating, the concluding article of the series discusses the care and maintenance required to keep these units operating at top efficiency. Notes on the installation, periodic inspection, and diagnosis of faulty performance are given in sufficient detail as to enable the shop electrician to insure long-lasting and satisfactory results. Every plant engineer will want to have a copy of this series of articles on hand for ready reference.

In addition to the above feature articles, the regular helpful information in the form of Shop Problems, Recent Developments, Data Sheet, and Business Items will allow the reader to keep his fingers on the pulse of the industry.

Barrel Finishing for Mass Production

By Herbert Chase

ANY factory installation capable of saving its own cost several times per year is properly rated an excellent investment. If, at the same time, quality and uniformity of the product are improved and scrap losses are cut to a negligible minimum, besides gaining other benefits, the possibilities may well interest the management of any plant having kindred operations to perform.

At the Endicott plant of the International Business Machines Corp., barrel finishing operations are now being done to marked advantage on some 8,500 different parts ranging from grey iron castings some 2½x4x14 in. overall and weighing about 6 lbs., to tiny parts weighing a small fraction of an ounce. Zinc die castings, steel forgings, scores of screw-machine products, hundreds of stampings in steel, brass, and aluminum and a wide assortment of other products are regularly subjected to surface treatment in barrels of many sizes and types.

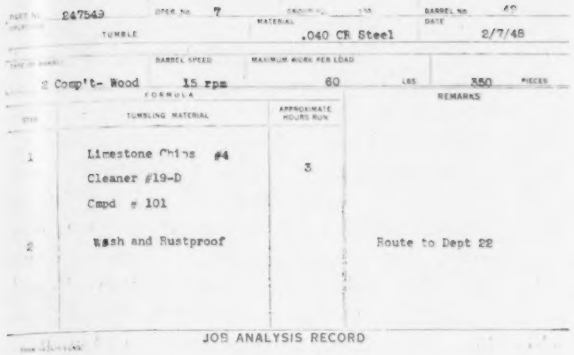
A large majority of these parts are treated to remove burrs or flash, eliminate sharp edges, or remove tool marks, but in all cases surfaces are smoothed, honed or burnished, some of them to an extent such that they are ready for plating without any wheel grinding or buffing. In nearly all cases, parts are handled in bulk lots ranging from a handfull to many thousands and at a far more rapid rate per piece than for hand operations as well as with greatly reduced labor charges over the prior methods. Quality and uniformity of work are both improved and scrap is reduced to nearly negligible amounts.

In all, there are five 45-in. and three 60-in. Roto-Finish barrels of two compartments each, 18 bottle-shape inclined single-compartment barrels of 22 in. diameter, two tanks with two barrels of 12-in diameter each, five bench barrels of about 12-in. diameter and two small cast iron barrels for ball burnishing small lots of parts. In all of these, the work is performed wet. Three inclined barrels are also used for dry work. There is also a screening machine and a washer in this department. All barrels have individual motor drive and automatic timers. The latter are set by hand at the start of a run and stop the barrel automatically at the end of the time set. The general layout of the department is illustrated in the photo at the beginning of this article.

This entire machine setup represents, with installation, including a tile floor and drain system, a total investment of about $75,000 and, as savings approximate $20,000 a month, the investment pays for itself several times over each year. A crew of nine operators, one clerk and one manager operate the equipment and put through 3½ to 4 million parts weekly. Average scrap loss has been reduced to about $18 weekly, being far lower than for methods formerly used. Rework is seldom required and the consumption of abrasives and chemicals is moderate.

As in nearly all other successful barrel finishing operations, it has been found expedient to vary the type of equipment used, the abrasives and chemicals employed, barrel speed, number of pieces per charge, duration and type of treatment, among other factors, to secure optimum results. Much depends, of course, upon the condition of the parts, the material from which they are made, their bulk and weight and the character of finish needed in determining the correct treatment to be applied.

For this reason, experience is exercised in choosing what appears to be the most promising treatment for a given batch of parts not barrel finished previously.



247549 OPER. NO. 7 BARREL NO. 40
TUMBLE .040 CR Steel DATE 2/7/48
BARREL SPEED MAXIMUM WORK PER LOAD
2 Comp't- Wood 15 rpm 60 LBS 350 PIECES
FORMULA REMARKS

STEP	TUMBLING MATERIAL	APPROXIMATE HOURS RUN	REMARKS
1	Limestone Chips #4 Cleaner #19-D Cmpd # 101	3	
2	Wash and Rustproof		Route to Dept 22

JOB ANALYSIS RECORD

Fig. 1. Sample card record. Each part has a similar record for constant reference.

Treatment starts with that already found suitable for the nearest equivalent part and results are checked every few minutes in the initial run until desired results are attained. Or, if it appears expedient, some changes may be made in materials applied and equipment used until a combination that yields satisfactory results is found. Once this has been found, a careful record is kept on a card (Fig. 1) and it is filed with all pertinent information as a guide to future treatment of the same parts.

If any troubles are encountered, if rework is required or if rejects run high, records of these and of changes found to effect a cure are entered under "Remarks" so that operators know how to avoid the same troubles when subsequent batches are handled. By making a card for each of the 8,500 different parts handled to date, a most useful file has been built up and guesswork is largely eliminated.

Although the card gives the type and duration of the treatment as well as the makeup of the tumbling medium, it does not give the proportions of the latter, as a rule, as the proportions vary for a given type of work and the type of barrel employed. Experienced employees soon learn the usual proportions but are required to check these against the table in Fig. 2. As will be seen from this table, all materials used are listed in the first vertical column and the remaining seven vertical columns show the amounts of each ingredient for each type of barrel or other machine.

When the part card (Fig. 1) specifies, for example, the use of a certain wood lined barrel, No. 3 granite chips, No. 11 compound and water, (as for the copper ring, Fig. 3) to be used in the 45-in. Roto-Finish barrel, the operator refers to column for this barrel (second vertical column, Fig. 2) and finds that 400 lbs. of granite chips, 4 lbs. of No. 11 compound and 12 gals. of water are required.

This ring, Fig 3, as received, carries heavy burrs resulting from milling operations and it requires 2 hours to remove the burrs from a batch of 500 pieces with the barrel turning at 15 rpm. The piece comes out

Recommended use of Tumbling Materials

Material	Bbls. 41-45 45" 2-Comp. Wood Lined	Bbls. 61-63 60" 2-Comp. Wood Lined	Bbls. 1-18 Bottle neck Tilting Barrels Neoprene Lined	Bbls. 21-24 Tank Barrels Neoprene Lined	Bbls. 30-35 Bench Type Barrels Cast Iron	Bbl. 20 #3 Tilting Barrel Neoprene Lined	Mach. #50 Turntable Washing Mach.
Water	12 gal.	20 gal.	2½ gal.	115 gal.	½ gal.	10 gal.	Alkali wash 241 gal. 1st Rinse 185 gal. Final rinse 206 gal
Granite Chips	400#	550#	* 1 Loading Pan	—	* 1 small Conveyor Pan	—	—
Alundum Chips	—	—	1 Loading Pan	2 Loading Pans	1 small Conveyor Pan	—	—
Limestone Chips	400#	550#	1 Loading Pan	2 Loading Pans	1 small Conveyor Pan	—	—
Soda Ash	1½#	3#	5 oz.	15# when charging tank	1 oz.	1¼#	Alkali wash 15# 1st rinse 7# Final rinse 0
Cleaner #37	1½#	3#	5 oz.	15# when charging tank	1 oz.	1¼#	Alkali wash 15# 1st rinse 7# Final rinse 0
Cleaner #19D	5-8#	6-10#	4#	—	1#	5#	—
Cleaner #10D	12 oz.	20 oz.	3 oz	—	½ oz.	10 oz.	—
Cleaner #59	1#	1½#	3 oz.	3# when charging tank	1 oz.	8 oz.	—
Brass Cleaner BBC	8 oz.	12 oz.	3 oz. Use no #59	—	1 oz.	—	—
Descaling Compound	—	—	12 oz. in hot water	—	2-4 oz. in hot water	—	—
Compound #11	4#	5#	—	—	—	—	—
Compound #101	1½#	2#	—	—	—	—	—
Sand	8#	10#	4#	—	1#	6#	—
Washer Compound #26N	—	—	—	—	—	—	Alkali wash 0 1st rinse 0 Final rinse 15#

* One small conveyor pan holds approx. 1⅓ gal. or ½ pk.
* One loading pan holds approx. 7 gal. or 3 pks.

Fig. 2. Table for proportions of materials used in the barrels.

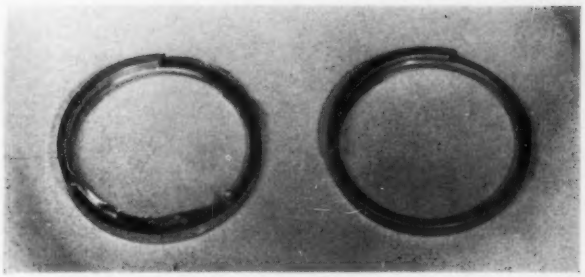


Fig. 3. Copper rings which are burred in barrels. Note heavy burr.

entirely free of burrs and is bright all over, all corners being somewhat rounded. When the tumbling operation is completed, only a water rinse and separation from the chips is required. As the treatment is applied to 500 pieces at a time, it is, of course, far faster than hand burring each piece separately.

Nearly all parts handled in large batches (except very small parts) are done in barrels listed in vertical columns 2, 3 and 4 of Fig. 2. All large parts and many of medium to small size are done in the Roto-Finish barrels (columns 2 and 3) each of which has two compartments that are wood lined. As the prime requirement, in most cases, is to remove burrs and round sharp edges, granite chips are chosen. Chips of No. 2 and No. 3 sizes are most used but the larger the size the faster is cutting. Sizes selected must be small enough to reach all surfaces that are to be ground but not so small as to lodge in any holes that the parts contain. Chips not in use are stored in bins that hold 800 lb. each, Fig. 4.

All large castings, including many in grey iron, are processed in 60-in. Roto-Finish barrels. Among the largest castings are two shown in Fig. 5. Parts of this size are burred, 20 to a compartment, using 600 lbs. of granite chips of No. 3 size and 1½ lb. No. 11 compound, the time being ½ hr. During the war, the same barrel and chip load were used on a 3 x 18 x 22-in. aluminum casting, one per compartment, tumbled for 25 mins. in 2 lbs. of soap, plus water, compound, and 2 bushels of wood blocks (to act as a cushion) were used. The saving realized over hand burring was $1.35 per casting. Fig. 5 shows many other parts done in the 60-in. and 45-in. Roto-Finish barrels shown in Fig. 6.

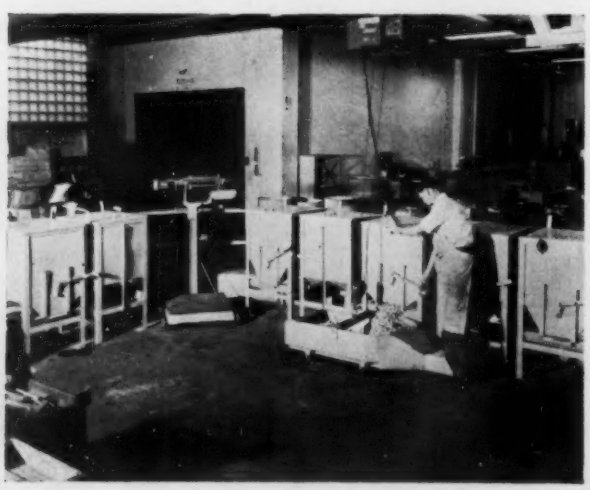


Fig. 4. Storage bins for ships, showing loading chute.

When considerable luster is required, as in the process called "Britehoning," limestone chips are employed. Their use may follow "grinding" in granite chips (which, of course, produce more of a cutting action) or limestone can be applied without first using granite unless a true grinding action is needed. The compound selected also affects cutting or honing action and must be suited, of course, to the character of work and to the chips, which the compound keeps from becoming glazed. To date, Britehoning with limestone chips has been quite limited at this plant, but may be extended in place of buffing to more parts that are to be plated.

Where parts to be barrel finished are of quite small size, and batches are not too bulky, the inclined bottle-shape barrel lined with Neoprene is preferred at I.B.M. and the abrasive is generally Alundum chips although granite chips are sometimes used. Choice as to size depends upon the parts to be treated. Alundum chips employed range from those of ¼-in. to 1½-in. screen size. Cutting is somewhat faster than for granite but there is also more wear on chips, hence their life is shorter.

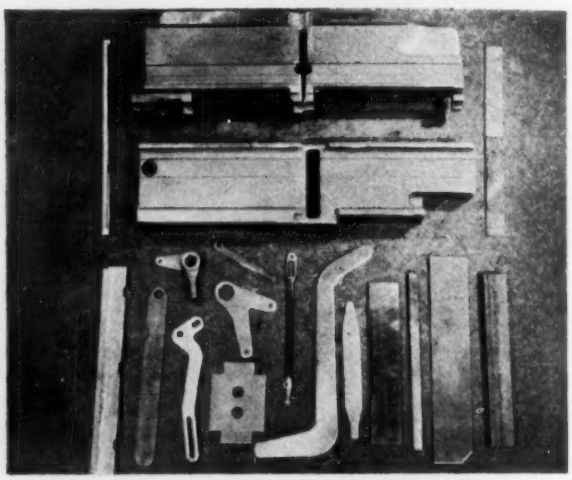


Fig. 5. Typical group of parts treated.

Compounds employed depend upon the metal being treated, its condition and the particular results required. As a rule, the compound includes some abrasive and an alkali, as Fig. 2 indicates, but, in others, no fine abrasive is needed.

In some early experience in barrel finishing, pitting of steel parts occurred. The reasons for this have never been determined definitely but it has been found that, if the ph is above 10.5, pitting does not occur, hence it is kept above this figure.

Among the parts done in the 22-in. inclined barrels turning at 22 rpm is a bezel, Fig. 7, about 3-in. in diameter. This was formerly produced in stainless steel and was received masked with tape that had to be removed before hand burring. The bezel is now drawn from low carbon steel and is barrel finished in Alundum chips that pass ½-in. but remain on ¼-in. mesh screen. The compound is Cleaner 10-D plus Cleaner #59 and water.

After wet tumbling and rinsing, the parts are dry tumbled for 10 min. in Maizo (ground corncobs) which, together with the prior treatment, yields a sufficient luster for plating. The saving in this case (not including that for the change in material) over hand burring was $5.50 per hundred pieces.

Indications as to other types of parts treated can be had by referring to Fig. 8. Many of the parts barrel finished have been hardened and some are tumbled after such heat treatment largely to remove scale. For this purpose, a descaling compound used with hot water and suitable abrasive has proved effective.

When practice as here outlined is employed, there is no nicking or undesirable scratching of parts, partly because with barrel speeds moderate, the parts are not thrown about but are subjected to a kind of sliding that causes a relatively gentle abrasive action on the edges and surfaces to be treated.

Barrels designed to turn slowly in tanks filled with

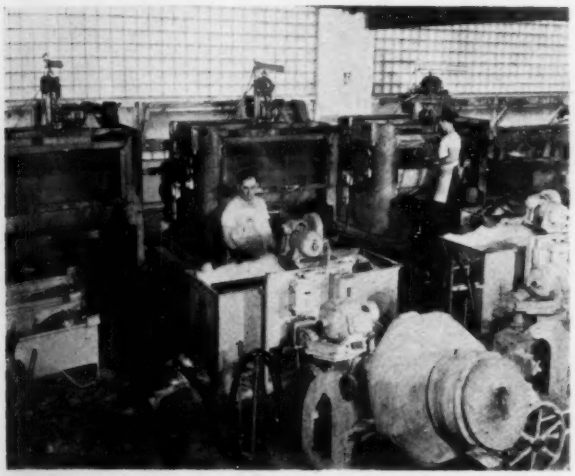


Fig. 6. Large double-compartment barrels for heavy work.

solution are employed for some parts. With this equipment, the barrels, which are perforated, are so nearly filled with parts and Alundum or limestone chips as to restrict relative motion. Time of treatment is usually quite long and the abrasive action on the driving mechanism of the submerged tanks has made maintenance costs high, hence the use of this type of equipment is relatively limited.

Bench-type barrels, Fig. 9, are employed chiefly for small lots of small parts. The principle and general application follows that for larger barrels, which would be used if the quantities warranted, except that barrel rpm is higher.

Batches of parts that are to undergo barrel finishing reach the barrel finishing department in tote boxes and, unless already degreased, are first loaded into vapor degreaser baskets, and passed through an enclosed, conveyor type degreaser using trichlorethylene. Thence, the parts are transferred in tote boxes to the barrels or to a loading pan in which mixing with chips may be performed. For large barrels, loading pans are handled by cranes with electric hoists.

Large parts, such as some castings, are often loaded and unloaded individually and are submerged before barrels are started so that impacts such as might mar

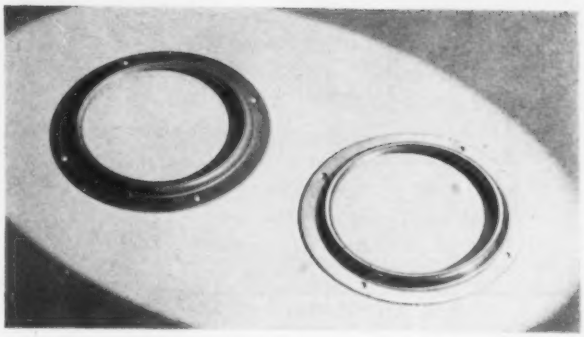


Fig. 7. Over five dollars per hundred saved on parts of this type.

machined surfaces, will be avoided. Small parts generally can be loaded through chutes (Fig. 4) without injury and can be dumped with chips onto screens or into the same pans used for loading.

After barrel finishing, the load discharged generally is hosed off and then the parts must be separated from chips by screening or other means. Although a magnetic separator for iron and steel parts is on order, it is not yet installed.

Most separating is done quite rapidly, however, by use of a power screen, Fig. 10, which also separates out chips that have been broken or worn below desired size in the barrels. This machine is equipped with four inclined shaker screens that range, from top to bottom, 1¼, ⅞, ⅝ and 5/16-in. mesh. Before the machine is started, a loading pan is hoisted onto an inclined rack which supports it so that the contents can be dumped slowly onto the top screen.

As a rule, the parts are caught on this screen and slide down into a tote box on a roller conveyor along which the box is pushed, when filled, to a washer. Most of the chips are caught on the second screen, as a rule and fall into a pan on the floor. Chips that pass this screen are separated on lower ones and are returned to bins, each holding a particular size for later use. Usually the largest chips are returned directly to some barrel without going to storage bins.

Parts too small for separation on the power screens are delivered to screens of smaller meshes where hand separation is done.

All parts, except those of brass, that have undergone

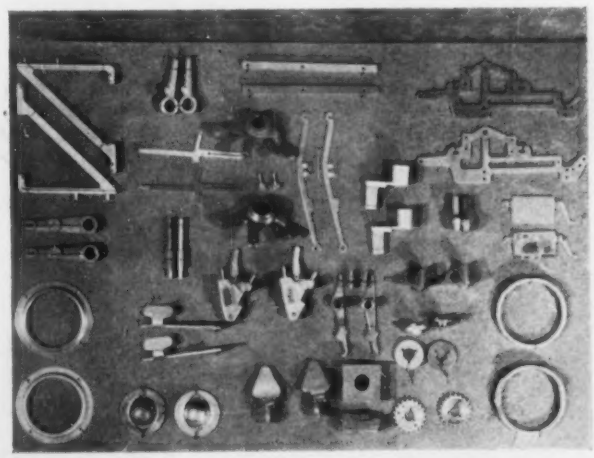


Fig. 8. Thin, light parts such as these are successfully handled.

wet barrel treatment go in baskets to the rotary washing machine, Fig. 11, where the basket is set on a turntable that carries it through four separate compartments. In the first two compartments the parts are spray washed and spray rinsed in alkaline solutions. For the wash, the tank holds 241 gal. of water to which is added 15 lb. of soda ash or Cleaner 37. The alkaline rinse tank holds 185 gal. of water in which 7 lb. of the same materials are dissolved.

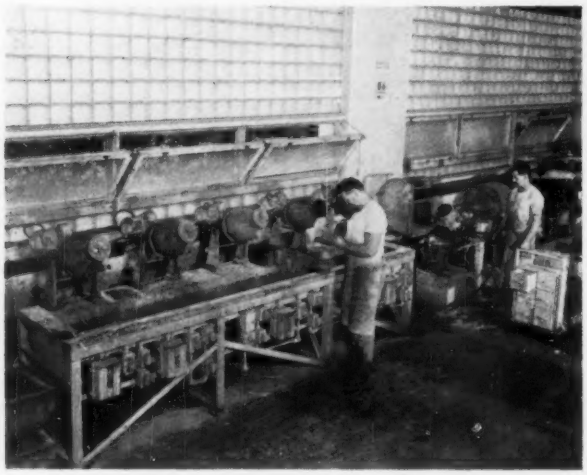


Fig. 9. Small bench units for light work.

Finish rinsing is from a tank holding 206 gal. of hot water to which is added 15 lb. of a rust-preventing solution which applies a coating designed to retard rusting. The final compartment is for drying in hot air. Baskets for small parts have wire mesh covers so that the high pressure spray which comes from both top and bottom will not throw the parts out of baskets.

Any parts that require further drying before leaving the department are centrifuged. Some are then dry tumbled in Maizo which, as already indicated, helps to brighten surfaces. Certain brass parts that are not well adapted to tumbling in even a mild abrasive are barrel finished in a brass burnishing compound used 3 oz. per gal. of water. This leaves the surfaces bright and there is enough self-abrading action between the parts to remove such fine burrs as are left on the parts.

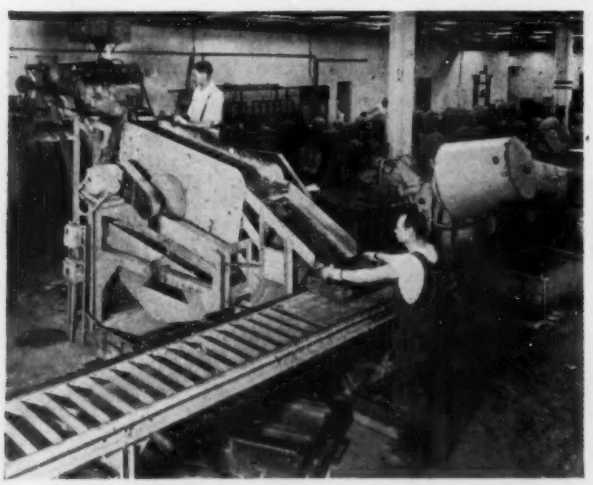


Fig. 10. Separating work from abrasives after tumbling.

Fig. 11. Mechanical washing machine for final treatment and rust-proofing.

Although a large proportion of the 8,500 business machine parts treated by barrel methods in this department can be tumbed wet in the manner described, there are some that are too fragile or that would become interlocked and bent if subjected to the treatments outlined. This applies especially to some thin steel stampings that require burring. Some such parts are successfully treated, however, by dry tumbling in open inclined barrels, Fig. 12, with clippings of emery cloth salvaged from worn out abrasive belts and discs used in other departments. Such clippings are light but the

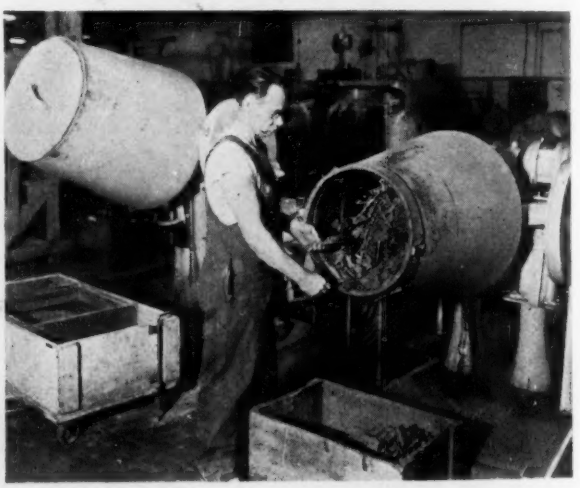


Fig. 12. Tilting barrels used for fragile parts and dry tumbling.

abrasive remaining on them has proved quite effective in burr removal and the slow tumbling action does not bend or otherwise injure the parts.

Uncounted other details might be added concerning specific parts that are barrel finished with marked saving and other benefits, but foregoing particulars give a good indication of what is accomplished. It need hardly be said that those concerned are well satisfied with the results being secured. This is evidenced by the constant increase in the number of parts being subjected to barrel finishing and by plans for increasing the equipment employed as may be necessary to handle the volume of work anticipated.

Anodes—Part II

By E. R. Thews, *London, England*

Editor's Note—The previous article in this series discussed the various factors involved in the use of Copper and Brass anodes. In this installment other metals are covered, including Gold, Zinc, Cadmium, Tin, Lead, and Chrome.

GOLD ANODES

GOLD plating is carried out with active gold anodes or with insoluble platinum, sheet-steel stainless steel or carbon anodes. Theoretically speaking, gold anodes are the most satisfactory for all practical gold-plating purposes. Their degree of solubility in most electrolytes is very high, the anode current efficiency in most common electrolytes being practically three times as high as the cathode efficiency. An exception to this rule are the electrolytes containing ferrocyanides, in which gold anodes turn passive, so that insoluble anodes are usually employed for this purpose.

Passivity of gold anodes is a difficulty frequently encountered, and it is for this reason that insoluble anodes are often preferred in spite of the additional trouble necessitated by the regular frequent addition of gold salts, etc., in order to maintain the electrolyte in a satisfactory condition.

Nevertheless, addition of gold salts is often preferred by gold platers, since under usual gold-plating conditions in small shops, this is a more dependable method of accurately controlling the composition of the bath than the use of gold anodes with their almost excessive degree of solubility on the one hand and their tendency to turn passive at most unexpected times and for most unexpected reasons on the other. As even comparatively slight changes of composition of electrolytes induce considerable changes of the gold plating (such as colour tints, brightness, gloss, etc.), the usual practice is to add gold salts at regular intervals.

Passivity of gold anodes may be caused by several internal and/or external reasons, i.e., by impurities of the anodes themselves or in the electrolytes. A number of metallic impurities, chiefly lead, silver, and larger percentages of bismuth and arsenic, induce passivity of gold anodes, although the amount of impurities required to actually cause the anodes to become passive is much higher than is usually found in gold anodes, unless these are prepared by the platers themselves by melting together all kinds of shop scrap.

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If pure gold anodes are used, difficulties from this source need not be expected, at least as far as passivity of the gold anodes is concerned. Lead is the most dangerous in this respect as it forms a dense film of lead superoxide and chloride which increases in density and thickness until the electrical resistance of the film has rendered the anodes passive. Silver causes passivity of gold anodes only if present in comparatively large percentages, while copper exerts a favourable influence in this direction. Indeed, copper in amounts of up to 1 or 2 percent improves the degree of solubility of the anodes and counteracts deteriorating influences of other impurities in this respect.

Passivity of gold anodes may also be caused by impurities in the electrolyte, or by the general composition of the electrolytes even if made up according to specifications. It has already been mentioned that electrolytes containing ferrocyanide induce passivity of gold anodes to such an extent that insoluble anodes should always be used in connection with electrolytic baths of this type. Ordinary pure cyanide electrolytes do not induce passivity of gold anodes, even in the presence of small quantities of common metallic impurities such as may be introduced by the anodes, etc. However, there are a few impurities which cause pronounced passivity of the anodes even if they are present in only minute percentages. This applies chiefly to sodium, present as impurity in many brands of commercial potassium cyanide. If sodium ions are contained in the electrolyte they cause the formation of a sodium-gold cyanide film on the anode surfaces. Pure gold anodes can therefore be used only if the potassium cyanide employed for the gold electrolyte is entirely pure.

Gold anodes yield satisfactory results only if they and the salts employed in the production of the electrolytes are perfectly pure.

Insoluble anodes can be made of any of the four types of material mentioned above (i.e., platinum, sheet steel, stainless steel and carbon), any one of them being applicable to any electrolyte. It is advisable in connection with the use of carbon anodes to tie them into dense-fibred anode bags in order to prevent fine carbon dust from entering the electrolyte and passing over to the cathode surfaces where they are bound to cause rough and porous gold deposits. The sheet-steel anodes yield satisfactory results only if they are properly annealed, i.e., if they exhibit a bluish coloration of the bright metallic surface.

As to the surface areas of soluble and insoluble anodes, attention is called to the fact that the area of the latter must be about three times as large as that of gold anodes. While the anode/cathode ratio amounts to 1:3, in the case of pure gold anodes, it is 1:1 where insoluble anodes of any of the other types are employed.

ZINC ANODES

The only material employed today for the manufacture of zinc anodes is purest electrolytic zinc. The advantage of pure zinc for this purpose has been realized

(Courtesy of Wagner Bros.)

Fig. 1. Ball and flat top types of Zinc anodes.

by most experts since the commencement of the zinc electroplating industry, but it proved technically difficult to realize this ideal until modern zinc refining processes rendered the manufacture of electrolytically refined zinc a commercial possibility. Up to about fifteen years ago technically pure rolled zinc anodes were used for all commercial work. The common impurities such as copper, lead, etc. were tolerated within the comparatively wide range specified for this grade of zinc, the only condemned impurities having been arsenic and antimony.

Fire-Refined Zinc

Gradual improvement of the fire refined grades of zinc induced correspondingly better grades of zinc plating, and it is a well-known fact that "pure" grades of rolled zinc anodes are frequently employed today (in spite of the available grades of purest electrolytically refined zinc) where bright zinc plating of high gloss is not required.

Nevertheless it is now a matter of common knowledge that the purest electrolytes require the purest anodes and that the electrolytically refined zinc now obtainable on a commercial basis always yields best results, irrespective of the kind of zinc plating to be produced. Apart from the higher quality of the pure plating obtained, their use avoids the various disadvantages induced by the introduction of impurities into the zinc electrolytes.

Apparent exceptions to this rule, such as the Tainton process, do not disprove this contention, as the basic principle of purity of the electrolytes is not in any way neglected.

Pure electrolytic zinc as anode material exhibits the one disadvantage that on account of the comparatively high anodic efficiency the electrolyte gradually becomes supersaturated with zinc. This applies particularly to the cyanide electrolytes of comparatively high potassium cyanide and sodium hydrate contents and, to a lesser extent, to the less alkaline baths and the zinc sulphate electrolytes.

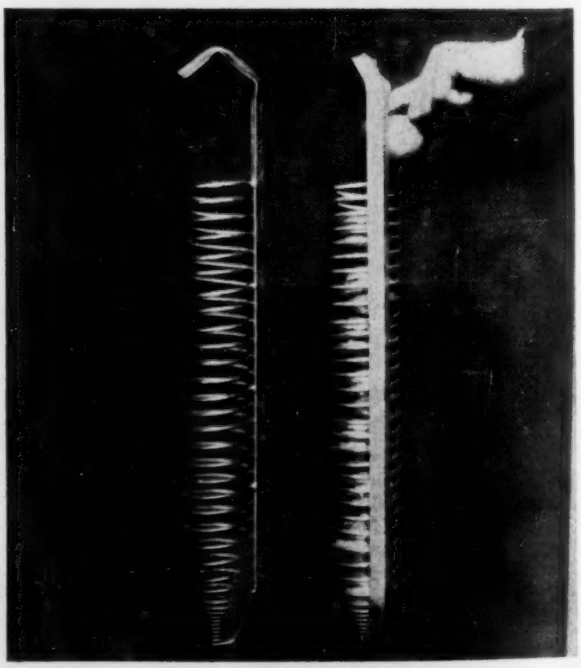
The excessive zinc content of the electrolytes leads to considerable slime formation and, finally, to the production of spongy zinc plating exhibiting inferior polishing properties.

These disadvantages are counteracted by using a suitable proportion of sheet steel anodes along with the pure zinc anodes. Still better results are claimed for auxiliary nickel anodes, although nickel plated sheet steel anodes can doubtlessly be employed with equal success.

The chemical character of zinc anodes does not render them very resistant towards the chemical action of the electrolyte. It is necessary, therefore, to remove them from the electrolyte at at every prolonged interruption of operations. After careful spraying with water the electrodes are then placed in vats filled with clean water until they are returned to the electrolytic vats. Leaving zinc anodes in a current-less electrolyte for any length of time induces the disadvantages of loss of zinc by chemical corrosion, saturation of the electrolyte with zinc and dilution of the acid content (in sulphate electrolytes).

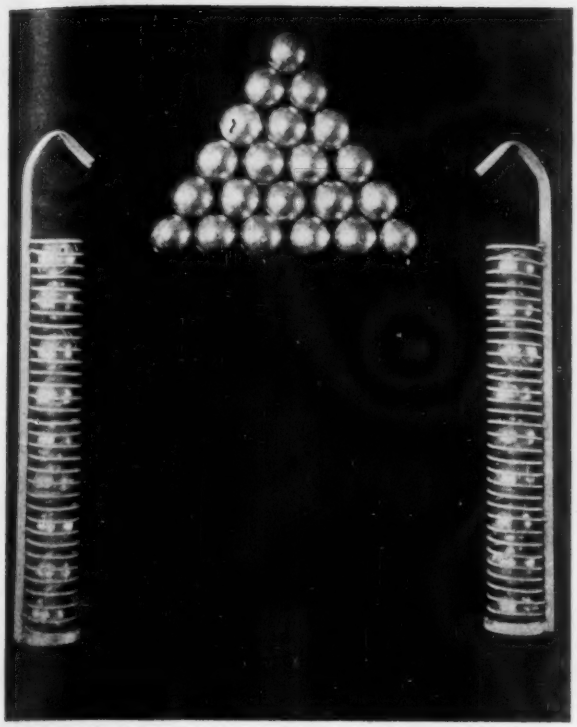
The ideal pH-value of these sulphate electrolytes is 4.0-4.6. The limits of this ideal range are not absolute, of course, being dependent on general plating conditions, but each electrolyte possesses its ideal pH-value which is bound to be disturbed by excessive solubility of the anode zinc.

There have been numerous attempts to diminish the degree of chemical and electrolytic solubility of anode zinc in electrolytes without interfering with the degree of purity proper. One of the most successful expedients has been the alloying of the anode zinc with metals such as aluminum, mercury and, for electrolytes of high acid content, with calcium and magnesium in comparatively small percentages. One of the approved compositions of this type is 99.4 per cent zinc, 0.18 per cent mercury, 0.42 per cent aluminum. Good results are claimed with a zinc containing 0.3 per cent mercury and 0.5 per cent aluminum. These additions reduce the formation of slimes, eliminate polarization of the anodes and (in acid solutions) tend to eliminate excessive differences between anode and cathode current efficiency, avoiding excessive acid consumption due to unnecessary anodic solution and ensuring constancy of the zinc and acid contents of the electrolytes.



(Courtesy Hanson-Van Winkle-Munning Co.)

Fig. 2. Cadmium ball anodes and basket-type holder.



(Courtesy Hanson-Van Winkle-Munning Co.)

Fig. 3. Ball-shaped anodes as used for Tin plating.

Bright Zinc

It is evident, therefore, that the chief disadvantage of pure zinc anodes, their excessive degre of solubility, can be diminished, or entirely eliminated, by suitable arrangement of the anodes, application of auxiliary anodes made of sheet steel, nickel plated sheet sheel or sheet nickel, removal of anodes from current-less electrolytes and alloying of the pure zinc with a small amount of one or a number of suitable metals. Attention is called to the fact that the alloyed zinc anodes should also be removed from the electrolyte during extended interruptions of operation.

These disadvantages for pure zinc anodes become still more pronounced in bright zinc electrolytes, and it is absolutely necessary to maintain an anode: cathode ratio of not higher than 1:2 or 2:3 in order to avoid super-concentration of the electrolyte.

If on account of excessive dissolution of anode zinc the pH-value of the electrolyte has been raised too far, additions of suitable amounts of acid will correct conditions, while in the reverse case zinc anodes are suspended in the current-less electrolyte.

While pure zinc anodes are used for practically all zinc plating operations, insoluble anodes consisting of lead with small percentages of silver are employed in the strongly acid electrolytes characterizing the Tainton process. Lead anodes containing 2.5 per cent silver are 20 to 25 times as resistant as pure lead anodes, although silver contents of only 1 to 2 per cent are usually employed.

An important feature of these lead alloys is that impurities such as bismuth, arsenic or antimony, which exert a very deteriorating influence in lead anodes, have no disadvantageous effects in lead anodes containing 1 to 2.5 per cent of silver.

CADMIUM ANODES

The well-known general similarity between cadmium and zinc plating applies to the cadmium and zinc anodes as well, which exhibit a number of strikingly similar characteristics. Both types of anodes must be of maximum purity, and both are highly soluble in their electrolytes. Indeed, the degree of solubility of cadmium exceeds even that of zinc, since under ordinary operating conditions the anodes are dissolved chemically as well as electrolytically, the amount of metal entering the electrolyte exceeding considerably the quantities corresponding to the electric current passing through the system.

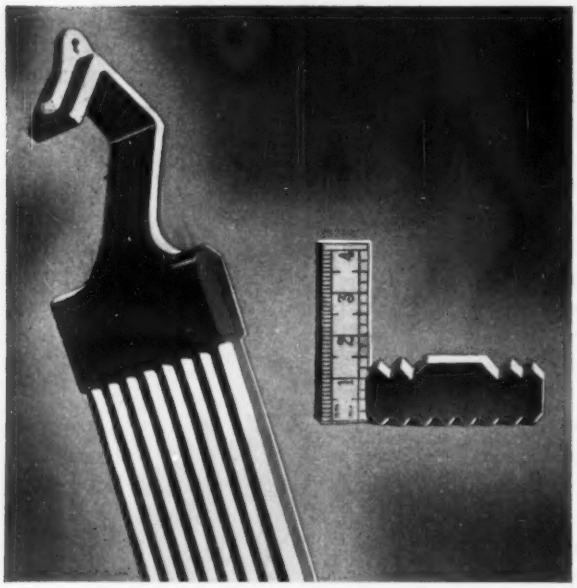
The degree of solubility of cadmium anodes increases with rising temperature and cyanide content of the electrolyte. Best results are obtained with a sufficient excess of free cyanide (about 5 to 10 oz/gal), but not exceeding a certain maximum depending on the general composition of the electrolytes. Too large a percentage of free cyanide in the electrolyte causes excessive gassing and anodic solubility as well as low current efficiencies. If, on the other hand, the free cyanide content does not reach the required minimum, a film only soluble with difficulty is produced on the anode, especially if the electrolyte contains too little cadmium and/or too much caustic potash.

In view of the high degree of solubility of cadmium anodes, the former eventuality seldom arises. If the anode area equals the cathode area, the amount of cadmium dissolved is much greater than that deposited on the cathode surfaces. It is necessary for this reason to reduce the anode area to only 25 to 70 per cent of the cathode area, the exact anode-cathode ratio being determined by the composition of the electrolyte, the operating temperatures and the electrical constants in question. In the majority of instances a ratio of 1:3 suffices to maintain the cadmium content of the electrolytes. Where larger anode areas are required to ensure correct electrolytic conditions, insoluble anodes of the required surface area are suspended along with the active cadmium anodes. The steel plate anodes employed for this purpose should not be too large dimensionally, however, since, apart from unbalancing the electrical constants, there is the danger of the contamination of the electrolyte with iron. It is true that the solubility of the anode steel is not very appreciable under normal cadmium plating conditions, and that small percentages of iron in the electrolyte are not harmful, but all possible sources of trouble must be avoided as far as practicable.

While a high degree of purity is the chief requirement made on the cadmium anodes for all ordinary

(Courtesy Republic Lead Corp.)

Fig. 4. Lead anode, showing means for increasing surface area.



(Courtesy Heil Process Equip. Co.)

Fig. 5. Multi-edged type of Lead anode.

plating work, some small percentages of certain metals are sometimes added to attain special results. This applies particularly to certain brightening agents such as nickel. Even very small percentages of this metal, apart from exerting a definite brightening effect, counteract the deteriorating action of pronouncedly harmful impurities such as antimony, arsenic, lead, silver, tin and thallium; 0.008 oz/gal of antimony and 0.0008 oz/gal of arsenic suffice to induce the formation of dark, rough or spongy deposits, although in contrast to lead, tin and silver, these two metals are not deposited at the cathode. Lead, tin and silver also cause the production of dark, coarsely crystalline and partly spongy cadmium deposits tending towards spalling or exfoliation.

In view of the chemical solubility of cadmium anodes in cadmium electrolytes, it is necessary always to remove the anodes from the electrolytes at every interruption of operations and to suspend them in a vat filled with pure water after removing all traces of electrolyte by careful spraying with a jet of water. Many platers remove their cadmium anodes every evening in order to ensure maximum anode life and to prevent excessive cadmium content of the electrolyte.

There have been numerous attempts to reduce the degree of solubility of cadmium anodes by the addition of small amounts of metallic elements exerting no deteriorating inflence in other directions. One of the elements suggested for this purpose is calcium, which is added in amounts sufficing to reduce the anode current efficiency to about the level of the cathode current efficiency.

TIN ANODES

Satisfactory results can be obtained only if the anodes used in tin plating are made of absolutely pure tin. High-grade Banca tin is most commonly specified for this purpose, lead being the most dangerous and deteriorating impurity. Apart from interfering with plating operations proper, the lead contaminates the tin plating, and since a major percentage of tin-plated material gets in touch with food, even small amounts of lead may prove dangerous.

The anodes stay bright in well-conducted acid electrolytes. Comparatively thin black layers may be formed on the anode surfaces, but this does not affect the progress of electrolysis and can be washed away with a strong jet of water.

Different conditions prevail in alkali electrolytes, where clean anodes are a certain indication of excessively low current densities. The clean anodes may also become covered with a loosely adhering film of dark particles, or they may become covered with a white or grey film. This latter phenomenon may also be caused by excessively high caustic soda content.

If on the other hand the anode current density becomes too high, the anodes turn black due to the formation of a film of black oxide or black spots are formed on a greenish-yellow base film. The black film gradually becomes insoluble and can finally be removed only with the aid of strong mineral acids.

Good operating conditions are always indicated by a greenish-yellow film, consisting of a mixture of stannic and stannous oxides. This coloration is quite characteristic and renders the optical control of tin-plating operations in alkali electrolytes comparatively simple. This film is due to oxidation by high current density. The appearance of dark spots or a general darkening of the entire surface soon indicates excessively high anode current densities, while gradual dissolution of the greenish-yellow film indicates a decrease of anode current density below the critical minimum.

Another indication of satisfactory current conditions is the moderate generation of oxygen gas at the anode. However, if too much oxygen is generated at the anodes, the formation of dark spots will soon indicate excessively high current densities.

LEAD ANODES

Anodes used for electrolytic lead plating usually consist of pure soft lead strips which are easily soluble at low and high current densities, maintaining the metal content of acid lead electrolytes practically constant. The anodic and cathodic efficiency in these electrolytes amount to 95-100 per cent.

Conditions are not equally favourable in the case of alkaline lead electrolytes which, however, are not of considerable technical importance. The anodic efficiency in these electrolytes is not as high as the cathodic efficiency which amounts to only 30-50 per cent, so that lead salts must be added to the electrolytes in order to counteract the gradual impoverishment of the metal content of these baths.

In the common acid electrolytes the anode area must be at least as large as the cathode area, although larger anode areas are often preferred. The permissable range is comparatively wide but must not be exceeded either way. If the anode area is too large in proportion to the cathode surfaces, the correspondingly decreased current density induces the production of coarsely

crystalline lead deposits, especially from electrolytes high in metal content.

The comparatively low degree of throwing power frequently necessitates the use of auxiliary anodes in order to obtain uniform lead plating even on very irregular surfaces. Specially shaped main and auxiliary anodes must also be used in many instances to obtain sufficiently dense and heavy lead deposits.

Anodes made of pure lead do not give rise to difficulties under ordinary, well-conducted operating conditions. Impurities are bound to lead to excessive slime formation as well as to rough and unattractive lead deposits. It has frequently been attempted in some European countries to add scrap metal to the anode lead material, but satisfactory results have not been obtained unless the scrap had been refined to at least 99.90 per cent.

CHROMIUM ANODES

In contrast to almost all other electrolytic processes operating with soluble anodes, or at least with soluble main anodes (many of the electrolytes requiring the use of insoluble auxiliary anodes) chromium-plating processes operate exclusively with insoluble anodes, the chromium content of the electrolytes removed by plating being replaced with suitable salts.

There have been many attempts to use active chromium anodes for this purpose, although the claims made for them are frequently based on faulty presuppositions. It should be generally known by this time that the real reason against the use of the soluble chromium anodes is not to be found in the difficulty of manufacture, so that old and new methods of manufacturing chromium anodes (for instance, by compressing and sintering of chromium powder, etc.) do not strike at the main problems themselves. It is true that due to the difficulty of working chromium the use of chromium salts is more economical than that of chromium anodes, but even this consideration would not keep the active chromium anodes entirely out of competition.

Insoluble Anodes

The real reasons for the exclusive use of insoluble anodes are: 1. That the speed of anodic solution is practically ten times as high as that of the cathodic current efficiency (10:100 per cent) so that the concentration and density of the electrolyte is bound rapidly to exceed all permissible limits. 2. That the chromium anodes are unable to reoxidize the chromium chromate (formed at the cathode) to chromic acid, the excessive concentration of chromate rendering the electrolytes useless within a comparatiely short period of time.

There have been many attempts to develop active anodes containing chromium as chief component, or processes using chromium as auxiliary anodes, together with insoluble anodes. It is obvious that if the percentage of active chromium anodes within the total anode area could be reduced to a point where the amount of chromium entering the electrolyte would exactly correspond to the quantity of chromium deposited at the cathodes, a number of problems could be solved at the same time. This idea could be realized in two ways: 1. About ten per cent of the total anode area could be made up of chromium anodes remaining in uninterrupted operation. 2. A number of chromium anodes could be inserted temporarily whenever the chromium content of the electrolyte decreases below a certain critical minimum.

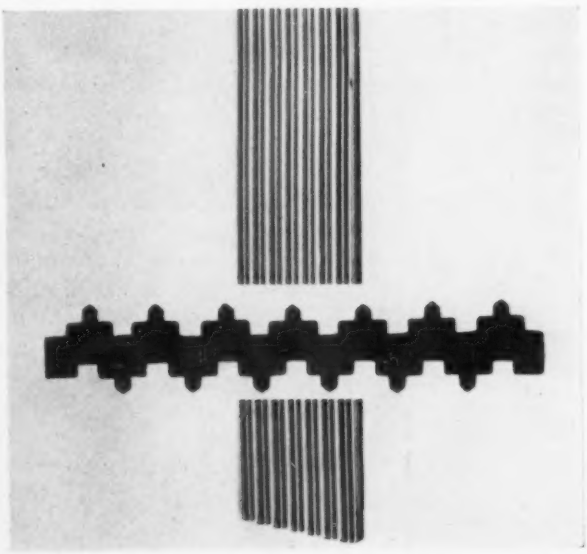
The former method is faulty in that it would not remove the main difficulties and it would still be more economical to add chromium salts. The latter method shares this disadvantage and introduces the additional difficulty that the composition of the electrolyte would not be constant.

Alloying Additions

Another method of utilizing chromium metal is to alloy the chromium with other insoluble metals, the percentage of chromium in these alloys being regulated so that a sufficient quantity of chromium is released into the electrolyte. Alloys of this type include nickel-chromium and iron-chromium-silicon alloys, etc., but all these mixtures have proved unsatisfactory for a number of reasons. Practically all of them introduce comparatively large percentages of impurities into the electrolyte, while the speed of solution of a number of these alloys proved to be greater than that of pure chromium anodes.

The search for suitable insoluble anode materials, led to numerous recommendations, including pure lead, lead-antimony alloys of various compositions, iron, steel and steel alloys, iron and nickel alloys rich in silicon, etc. Of all these and many other materials only lead and lead-antimony alloys were found to be satisfactory.

The question as to the relative superiority of these two anode materials is usually answered in favour of the lead-antimony alloys, although pure lead anodes exhibit a number of advantages over the lead-antimony alloys and are still being used for anodes of complicated shapes (adapted to the surfaces of complicated cathode shapes) and auxiliary anodes for comparatively small parts.



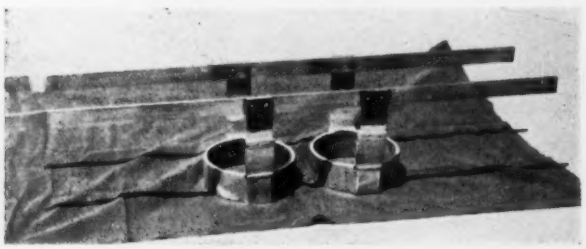
(Courtesy of Division Lead Co.)

Fig. 6. Another popular type of multi-edged Lead anode.

Lead Anodes

A decided advantage of pure lead anodes is that they are somewhat more resistant to anodic dissolution, resulting in a longer period of life with uninterrupted electrolytic operation, while their corrosion resistance towards the electrolyte with the current turned off is decidedly less pronounced than that of lead anodes containing 5 or 6 per cent of antimony. This chemical resistance of pure lead is considerably improved if the anodes are anodically oxidized after suspension in the electrolyte, the thin lead superoxide film produced diminishing the attack of the electrolyte on these anodes. Nevertheless, it is necessary to remove pure lead anodes from the electrolyte as soon as the current is interrupted and to spray off the remaining electrolyte. The chromate layer formed on the anodes must be removed at regular intervals, at least every seven or eight days, and the surface cleaned so as to leave no chromates. If this operation is carried out with due care, the oxide film produced by anodic oxidation need not be destroyed.

The resistance of the lead anodes to the chemical attack of chromium electrolytes with the current turned



(Courtesy Heil Process Equip. Co.)

Fig. 7. Specially shaped Lead anodes for plating chrome on cylindrical objects.

off grows with increasing antimony content. The antimony content of these anodes usually amounts to 5 or 6 per cent. In the case of almost uninterrupted operation the antimony content sometimes decreases to 1.0 or even 0.5 per cent, while for some electrolytes containing special additions, such as fluorides, the antimony content may rise up to 13-20 per cent.

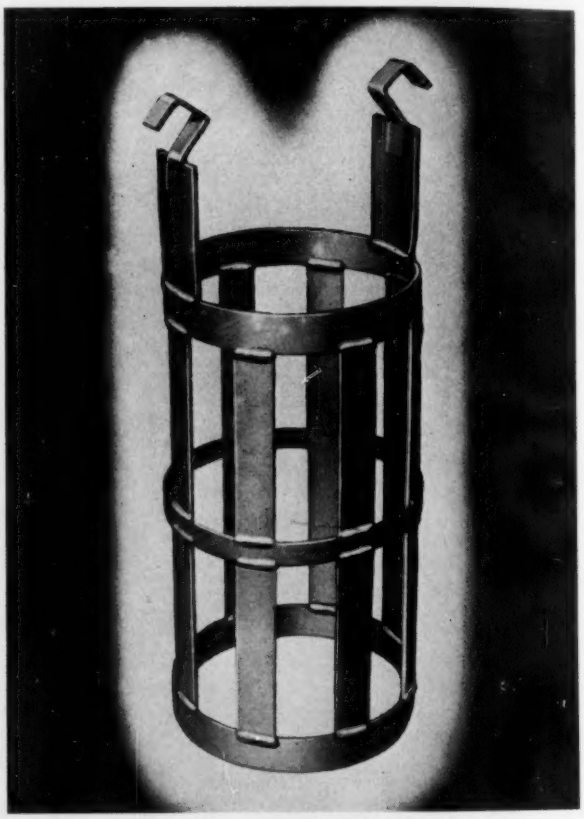
All the anodes containing 5 per cent antimony and more remain practically uncorroded under normal operating conditions and with correct maintenance. A certain loss of weight due to the gradual formation of reddish-yellow lead chromate cannot be avoided, but the loss incurred by the regular removal of these layers is comparatively small. Mechanical cleaning is effected by means of metal brushes, scrapers, spatulas, etc., while the chemical cleaning methods recommended involve cleaning solutions usually containing chlorides. A solution of this type is a concentrated aqueous solution of sodium chloride acidified with hydrochloric acid.

It is possible, of course, to diminish this rate of loss considerably. A common precaution is the removal and cleaning of the anodes every evening or at every prolonged interruption of operations. The lead chromate is then formed at a much lower rate, and the layers produced are comparatively loose, dropping to the bottom of the vat as soon as they have reached a certain age and thickness.

Anodic Treatment

Relatively loose chromate layers are also formed if the new hard lead anodes are anodically treated in a sulphuric acid electrolyte for one or two days, the lead peroxide film produced reducing the adhesion of the chromate layers to the anode surfaces, from where they can easily be removed by brushing. The brown peroxide film does not influence the electric conductivity and possesses no other practical disadvantages as long as it is uniform and adherent.

There can be no doubt that the rate of formation of lead chromate layers can be influenced by proper manipulation of the chromium-plating processes, and it is a fact that some platers never remove their hard lead anodes from the electrolyte excepting for a thorough cleaning once every two weeks, without experiencing



(Courtesy Heil Process Equip. Co.)

Fig. 8. Basket type cylindrical anode for chrome plating long tubular parts.

serious difficulties. Favourable operating conditions of this type are perfectly satisfactory as long as they conform to the normal operating conditions involved. However, these conditions should not be modified for the sole purpose of reducing lead chromate formation, since it is not the chief purpose of commercial chromium plating to enforce minimum lead chromate layers, but to produce good chromium deposits at minimum cost. If this principle is conscientiously observed, normal formation of lead chromate films (in spite of correct maintenance of anodes) will never be a major trouble.

The size of the anode area relative to the current density and the cathode area is of particular importance

(Continued on page 75)

Rectifiers for Electroplating—Part VI

By Louis W. Reinken, *Chief Engineer, W. Green Electric Company, Inc., New York, N. Y.*

In the earlier parts of this series the basic theory of rectifier equipment, typical circuits and details of automatic control systems was discussed.

The remaining articles will deal with the practical considerations of rectifier installation and maintenance. A considerable variety of rectifier equipment is now being manufactured, but it is believed that the following notes will apply generally to most rectifiers.

A complete set of reprints on this series may be obtained by writing the Author.—Ed.

General

Rectifiers for electroplating were relatively new before the war, but the 'round-the-clock operation during the war and the considerable number of units installed during that period provided experience equivalent to about ten "normal" years. Better grade rectifier equipment stood up to war production use surprisingly well, but there was a certain percentage of field trouble.

Some of the trouble was due to optimistic design or component failures, but impartial study shows conclusively that the great majority of field troubles could have been avoided if the installation had been more carefully planned. The rectifier manufacturers must, collectively, take at least part of the responsibility for this situation since "education" of the electroplaters and the maintenance men is part of their job.

Furthermore, since the key components of rectifier equipment—transformers, rectifier elements—have no moving parts and are not mechanical in nature, it was frequently not realized that the equipment was being abused until the damage had been done. Corrosion, dirt accumulation, excessive temperature, and similar enemies of rectifier equipment do their work silently.

Most manufacturers incorporate one or more protective devices in their rectifier equipment and, although these devices are desirable, none of them will provide complete protection against *all* forms of rectifier abuse. (And, remembering a *few* cases which occurred during the war, it is justifiable to recall the old saying about "You can make a machine foolproof but not damfoolproof".)

Electrical Installation—Single Phase Rectifiers

The *electrical* part of rectifier installation is generally carried out better than the physical part (which will be discussed later).

For small rectifiers operated from 115 volt single phase supply, there is usually no special wiring required on the input (A.C.) side. These "bench" rectifiers are normally equipped with a cord and a standard plug which may be connected to a standard wall outlet. The only precaution necessary is to make sure that the particular circuit from which the unit will be supplied will not be overloaded.

As an approximate guide, a 6 volt, 25 ampere rectifier will draw about 2.5 amperes from the 115 volt A.C. supply when operating at full load, and larger units will draw larger line currents in proportion to their rating. Since most A.C. supply circuits are rated to carry up to at least 15 amperes, there is seldom any need to worry about overloading the A.C. circuit unless a number of devices are already connected to this same circuit.

Input Protection

Most small rectifier units are equipped with an ON-OFF switch of the circuit breaker type, which will automatically trip to the OFF position if the normal A.C. line current is exceeded. This protects the supply circuit and also provides some measure of protection for the rectifier. In addition, the rectifier unit should incorporate a fuse associated with the circuit in such a way that the fuse will blow if the current drawn *from* the rectifier substantially exceeds the rectifier rating—regardless of the *voltage*—which the rectifier is delivering to the load.

Output Protection

At first glance, it would appear that this second protective device (such as the "output fuse") is unnecessary, and that the circuit breaker switch in the A.C. input circuit should be sufficient. However, this is

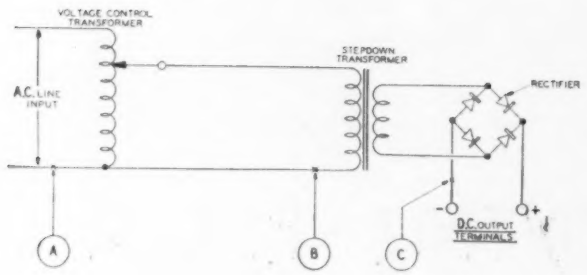


Fig 32

not so, and the electrically-minded may be interested in an explanation.

For simplicity, let us assume that the efficiency of a typical rectifier unit is constant, regardless of the D.C. output voltage and of the load current—even though this is not strictly true. Let us assume also that the unit is rated at 6 volts, 25 amperes maximum, draws 2.5 amperes from a 115 volt A.C. supply circuit at 6 volts, 25 amperes, and is equipped with an input circuit breaker designed to trip at 3 amperes. In other words, the A.C. line current is 2.5 amperes when the unit is delivering 6 x 25=150 watts. Assuming that the efficiency is constant, then the line current will also be 2.5 amperes when the output is 3 volts, 50 amperes (=150 watts). However, 50 amperes is double the rated maximum current of the unit and the rectifier element will be damaged if operated for any length of time at this current. It will be noted that, although the rectifier element is being operated at twice its rated current, the line current is only 2.5 amperes, the input circuit breaker will not trip out, and therefore, the breaker provides no protection for this condition.

The key to this situation (which is different from that of most other electrical devices) is the voltage control system which is almost always a transformer (tapped or continuously variable) between the A.C. supply line (in which the circuit breaker switch is located) and the stepdown transformer feeding the rectifier. Changing this transformer ratio changes the relationship between line current and the D.C. load current so that it is impossible to limit the load current to a definite value by means of a circuit breaker, fuse or other device *in the line circuit.*

This can be seen in the simplified schematic (Fig. 32), in which Point (A) is the logical location for an ON-OFF circuit breaker switch.

At Point (C), it is possible to insert a fuse which will definitely limit the maximum D.C. output current from the rectifier. In smaller units, such a protective circuit is used, with the fuse conveniently located on the control panel. The fuse rating at Point (C) must be equal to, or slightly higher than, the full load D.C. ampere rating of the unit—i.e., 25 amperes for a 25 ampere unit, 50 amperes for a 50 ampere unit, etc.

Up to about 25 amperes, this output fuse method is practical, but for higher current units it may be difficult to obtain suitable fuses and fuse holders. In such units, a fuse of lower current rating can be used to provide equal protection by locating it at Point (B). The current at this point is considerably less in amperes than the current at Point (C), and is determined by the ratio of the stepdown transformer and the type of rectifier circuit used. For a 6 volt, 50 ampere unit, a fuse of about 5 or 6 amperes rating, located at Point (B), will provide ample protection. It should be noted that this fuse *follows* the variable ratio voltage control transformer, and therefore the fuse current depends only upon the amperes drawn from the rectifier, independent of the D.C. output voltage.

Three Phase Rectifiers

A.C. Input

High capacity rectifiers of the kind required for full-scale production are usually built to operate from 220 or 440 volt three phase power supply. Obviously, these are not of the "plug-in" type, but must be connected to the three phase supply in the same manner as any large electrical machine.

Local regulations (or "code") generally require for such installations, the provision of a fused manual cut-out (i.e., combination switch and fuse box) external from the rectifier and located between the three phase supply and the input terminals of the rectifier. This cut-out should be located at a point conveniently near to the rectifier so that the rectifier can be completely cut off from the A.C. supply in case it is desired to open up the unit for inspection or maintenance.

The rectifier manufacturers' instructions usually specify the correct size of fuse to be used in the cut-out box, and this indicates also the minimum size of wire to be used between the cut-out and the rectifier, and between the cut-out and the A.C. supply.

Any wiring or electrical installation must be done by a qualified electrician experienced in three phase work. This not only ensures that the rectifier has been properly connected, but facilitates obtaining approval of the local underwriters and municipal authorities. Of course, the electrician should have available the rectifier manufacturer's instruction booklet or sheet.

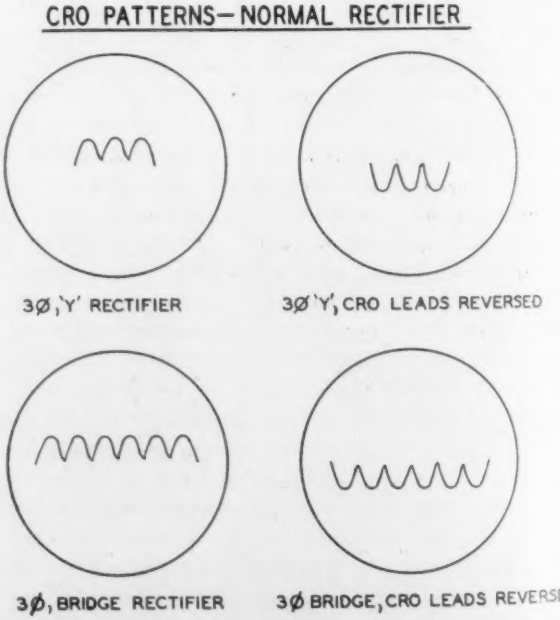


Fig. 33

CRO PATTERNS—DEFECTIVE RECTIFIER

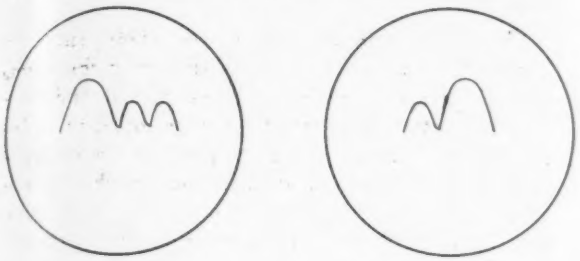


Fig. 34

PROTECTION

The input fuses referred to in the preceding section are generally specified on the basis of the A.C. line current which will be drawn at full load voltage and current, plus a margin to avoid excessive fuse blowing in the region of full load, or during a surge when starting up a fully loaded tank.

By the same line of reasoning "Output Protection" where single phase units were discussed, it can be shown that these input fuses serve only to limit the maximum current which may be drawn from A.C. supply circuit and cannot provide uniform limiting of the D.C. output of the rectifier. The input fuses protect the A.C. supply circuits (as required by law) and provide "output protection" only under special conditions—such as a shortcircuit in the tank, or excessive tank current at or near the maximum rated voltage of the rectifier.

It will be recalled from an earlier article in this series, that in fan-cooled rectifiers the basic index to rectifier breakdown is the temperature of the rectifier elements and not just the load current. This is discussed in some detail under "Rectifier Construction—Ventilation" in Part II of this series. In order to avoid repetition, your attention is called also to the circuits and notes under "Protection" in Part IV, which illustrate several different protective systems used in three phase rectifiers.

It will be noted that in all three of the systems described in Part IV, an essential component is the magnetic contactor between the A.C. source (fused cutout box) and the rectifier. This magnetic contactor, which is supplied with the rectifier either built-in or as a separate component, is simply a three-pole switch operated by a magnetic solenoid instead of by hand. The magnetic operation makes it possible to "trip open" the contactor (and hence the main A.C. supply to the rectifier) by means of protective thermostats, fan switches, etc. connected in the circuit of the solenoid coil. The contactor also permits the relatively simple addition of duplicate, remote ON-OFF push button control.

Parallel Rectifiers

INPUT PROTECTION

There are many installations where two or more rectifiers have their D.C. outputs connected in parallel in order to provide high current capacity. (See Part III) Where this is done, it is necessary to avoid the mistake of connecting the A.C. input circuits of the rectifier units to a common fuse box equipped with large fuses rated to carry enough amperes to supply all the rectifiers simultaneously. Although such an arrangement appears economical and will protect the A.C. supply line, it reduces the protection afforded the individual rectifiers.

Suppose, for example, that two similar rectifiers are connected in parallel to the same tank, and are supplied from a common fuse box equipped with fuses of double the ampere capacity specified for one rectifier. Then, if one rectifier should shut down for any reason (for instance, because its protective device tripped open the contactor), the load on the other rectifier would increase and could easily be double the rectifier rating. The input fuses would *not* blow, even though the rectifier was operating at abnormal overload, and the rectifier might be damaged before its thermostat or other protective device had time to function.

A much better arrangement would be to provide an individually fused cutout for each rectifier unit, equipped with fuses of the correct size. Then, if one rectifier cuts out and the load on the remaining rectifier(s) is abnormally high, the worst that can happen is that one or more fuses will blow—but fuses cost far less to replace than a damaged rectifier element.

Where a custom-built installation is being planned for parallel operation, it is sometimes possible to provide interlock circuits so that shutdown of any one rectifier unit will automatically trip the contactors of the other units, thus shutting down the entire installation and avoiding the possibility of overloading the remaining units. This arrangement, which may or may not be desirable, depending upon the particular installation, is generally practicable only if a master remote control forms part of the rectifier group.

There is one special case of parallel operation which needs further discussion, and that is where each of the rectifiers is provided with an individual set of fuses of normal rating, and the rectifiers *must* be started up with the tank *fully loaded*. It can be seen that if the tank load is high enough to require the services of more than one rectifier, the first rectifier which is turned on will be momentarily overloaded until the other rectifiers have been started and have taken up their share of the load.

If the fuses are of the quick-acting variety, then the

CRO PATTERNS—NORMAL STACKS

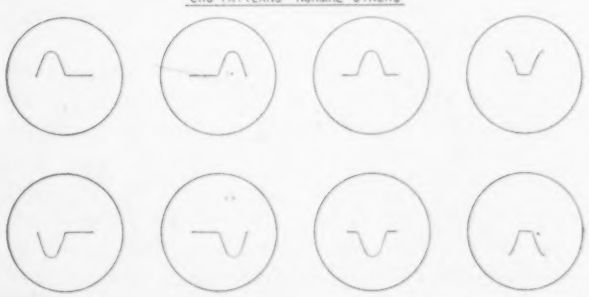


Fig. 35

fuses of the first unit started may blow before the operator can press the start buttons of the other units.

There are two possible solutions to this problem:

(1) Start the rectifiers with the tank partially loaded (or completely empty).

(2) Use fuses of the high-lag type which will carry a considerable overload for a period of time long enough to allow the other start push buttons to be pressed.

This latter method (high-lag fuses) has been used successfully not only to permit the starting of parallel rectifiers under full load, but also for individual rectifiers supplying D.C. to a process where there is a momentary "surge" at the beginning of the process—anodizing, for example.

As explained in earlier articles, most metal rectifiers can take temporary overloads for *short* periods without trouble. Therefore, they can be associated with input fuses having a time-lag characteristic provided the fuse capacity is correctly chosen.

Installation

Ventilation

A rectifier unit is an electrical machine—not an acid-proof tank. If it must be located in the plating room, then it is elementary that the location must be such that the rectifier is not subjected to splashing from

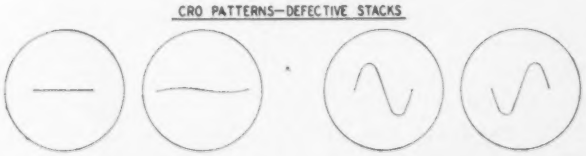


Fig. 36-A Fig. 36-B

nearby tanks, nor to spraying when the floor is hosed down.

The most important consideration is that of proper ventilation. This has been referred to in Part II, and some of the notes which appeared there are important enough to justify repetition:

"In properly engineered rectifier equipment the designer has made sure that the fan or fans incorporated will provide sufficient air flow to keep the temperature of the plates at a safe value provided the unit is not operated above its rated current capacity in normal surroundings, and provided that neither the air intake nor the air exhaust is interfered with in any way.

"If the plant layout is such that the rectifier units are installed in a comparatively restricted space, then there is the possibility that the exhaust air which has already been raised a few degrees in temperature by the heat absorbed from the rectifier elements, may be drawn again into the air intake and thus successively recirculated through the unit. Obviously, the air will continue to rise in temperature and so will the temperature of the rectifier elements.

"This recirculation cycle must be broken either by permitting the exhaust air to pass out of the rectifier bay or by arranging for fresh air to be drawn into it.

"The latter arrangement is preferable since air drawn from almost any source other than the plating room is likely to be cleaner, less corrosive and lower in temperature than the atmosphere found in a plating room. Some modern plating rooms are equipped with very well ventilated tanks, and in this case, it may be possible to locate the rectifier units comparatively near the plating tanks with no special ventilation precautions.

"If ventilation ducts, either intake or exhaust, are provided care should be taken to see that the ducts are of ample cross-section and reasonably short so that air flow is not impeded. It is obviously bad installation practice to equip a 5,000 ampere rectifier unit requiring perhaps 6,000 c.f.m. with a stovepipe duct 10″ or 12″ in diameter. It is preferable to choose a location for the rectifier reasonably close to a shop window and then fit a *large* duct between the rectifier and the window space."

Air Filters

A considerable volume of air is moved through a rectifier unit during the course of a day. (A typical large unit may be equipped with fans having a total rating of 5,000 c.f.m.) Obviously, some of the dirt and dust in the air will be deposited inside the rectifier cabinet—and especially on the edges of the rectifier element plates. Good housekeeping requires regular removal of this accumulated dirt, the frequency of cleaning depending upon the relative dirtiness of the atmosphere.

In some locations, for instance near a polishing shop where the air is loaded with buffing wheel fluff, or near a freight yard, the air will be so dirty that it may be considered desirable to use a filter in the air intake duct.

An air filter will increase the resistance to air flow, the amount of increase depending upon the type of filter and thickness of the filter material. The required filter thickness (and hence the amount of increase in air flow resistance) depends upon how much, and what kind of, dirt must be removed from the air. With use, as the filter clogs up, air flow resistance will increase and the filter must either be replaced or cleaned.

In any case, the increase in air flow resistance *must* be compensated for by a supplementary fan or blower located somewhere in the air intake duct. The rating of the supplementary fan must be based on the worst conditions—i.e., the expected resistance of the filter just before it is cleaned or replaced. Charts are available for all types of filters correlating type of filter, degree of accumulated dirt, area, and air flow resistance.

An air filter installation with supplementary fan (or any duct installation, for that matter) is best planned and supervised by an experienced ventilation engineer. This part of the installation should be turned over to a ventilation man just as the electrical installation should be executed by a qualified electrician. About the only rectifier data which the ventilation engineer should re-

quire is the normal air flow through the unit *without* filter and intake duct, and this can be obtained from the manufacturer.

Cold Weather Problems

In large rectifier installations equipped with air intake ducts leading to outside air, there may be a heating problem in winter due to the quantity of air brought in from the outside. This problem has been solved in the same manner as that used in air conditioning or ventilating systems: by *mixing* inside air with outside air, or even by drawing all the intake air from inside the building.

Of course, the need for avoiding corrosion is just as important in winter as in summer, and the source of inside air must be relatively free of the corrosive vapors generated by most plating tanks.

If the layout is such that the rectifier units are not in the plating room proper but are walled off in a separate power supply cubicle, then the heating problem is greatly simplified since the power supply room may be allowed to run cold.

Installation—Summary

The foregoing notes may give the idea that installation of rectifiers is a critical and difficult problem. This is not so. The installation of rectifiers is no more difficult than that of other types of power supplies—the key features are simply *different*. Time spent in planning and executing a good installation will be well repaid by low maintenance cost and long life of the equipment.

Regular Maintenance Procedure

Normal maintenance of rectifier equipment (as distinct from trouble-shooting) is relatively simple. These are the three key maintenance requirements:

(1) Lubricate fan with grease or oil as specified by rectifier manufacturer at regular intervals, depending upon how many hours per day the rectifier is in use.

(2) Replace pilot lamps when required.

(3) Remove accumulated dirt or dust regularly from inside the unit, particularly from the rectifier elements, using a soft brush or cloth—or better yet, an industrial vacuum cleaner fitted with a soft brush. Cleaning schedule depends upon local air conditions, running time per day, and whether or not an air filter is used. If an air filter is used, this must be replaced or cleaned regularly.

Trouble-Shooting

In case of trouble, the logical procedure to locate the source will be evident (to an experienced electrician) from the circuit diagram of the unit. Typical circuits were shown in earlier articles in this series, but for each unit the circuit schematic supplied by the manufacturer should be consulted.

Rectifier equipment is essentially simple. The basic circuit usually consists of a voltage control transformer, stepdown transformer, and rectifier stacks. Auxiliary circuits (see Part IV) are concerned with ON-OFF control, fan, protective devices, pilot lamps, meters, etc.

Repair costs may be minimized if, wherever abnormal operation is observed, an electrician is put on the job as soon as possible. Preferably, the rectifier should be shut off immediately there is any suspicion of trouble—or if this is not possible, then the load should be reduced as much as possible. In many cases, a defective rectifier unit may be operated at reduced load without damage until an electrician can be obtained, whereas full load operation may cause considerable expense.

Typical symptoms of abnormal operation are:

(1) A substantial drop in voltage below that usually obtained at the same tank current and with the same setting of the voltage controls.

(2) Excessive vibration or noise. (This may accompany "(1)".)

(3) Repeated operation of the protective devices, especially if the load current is below the maximum rating.

(4) Excessive heat in the cabinet or a burning smell.

Circuit Tracing

Most larger rectifiers are of the three phase type and the electrician can usually isolate the source of trouble most quickly by comparing the individual phase voltages as the circuit is traced through. Quite frequently the cause is simply that one of the three fuses in the external cutout box is open and this should be checked first of all. Any of the four symptoms previously listed can be caused by a defective fuse, since the rectifier will be operating in an unbalanced manner with nearly all the load placed on one phase.

If a clamp-on ammeter is available, then measurement of the line currents in the three conductors leading to the rectifier should be made. These three currents should be reasonably alike at substantial loads, with a slight unbalance due to the current drawn by single phase devices such as the fans and the contactor coil. Line current measurements at no load or at small loads are relatively meaningless. If the line currents at heavy loads are very different, then the unit is definitely not operating properly and a voltmeter should be used to track down the point at which the rectifier has gone off the rails.

Assuming that the external fuses are O.K., then the three phase voltages should be compared through the circuit, preferably with partial loads on the rectifier. Typical points to measure would be: line terminals of contactor, load terminals of contactor, primaries of stepdown transformer (i.e., wiper terminals of voltage control switches or Powerstat), secondaries of stepdown transformer.

This procedure will frequently locate the source of trouble quickly. For instance, if normal voltages are measured on the line side of the contactor but not on the load side, then the contactor is defective. This can be confirmed by measuring *across* the pairs of contacts from line to load side to locate the defective contact. Contactors are invariably constructed to permit

simple replacement of a burned out contact and new contact fingers may be obtained from the rectifier manufacturers or a local electrical supply house.

If voltages are normal on the load side of the contactor but unbalanced at the primaries of the stepdown transformer, then the voltage control switches or the wiring to the switches should be suspected.

If the trouble report is that the tank voltage does not increase and decrease in uniform steps as the switches are rotated, then it is almost certain that one or more of the contacts in one or more of the switch sections are defective. This can be confirmed by comparing the primary voltages of the stepdown transformer (or the voltages across pairs of switch wipers) for *each* position of the switch. The defective position will show up immediately as a large unbalance in voltages.

A defective switch should be completely replaced with a new switch of the same type, being extremely careful not to mix up any of the leads removed from the switch during changeover.

Defective Rectifier Elements

If, throughout the rectifier, from beginning to end, all voltages are balanced all the way to the secondaries of the stepdown transformers and still abnormal operation (such as unbalanced three phase *currents*) is observed, then the rectifier elements ("stacks") may be suspected. Without special equipment it is not easy to locate a defective rectifier element *electrically*. Frequently a defective selenium element can be distinguished from the others by signs of burning or by the presence of melted alloy which has collected in drops at the lower edges of the plates, or has dropped onto the transformers or the cabinet bottom. This alloy resembles bright solder in appearance and its presence is a certain sign of a burned out stack. Such a stack must be replaced with a new stack of similar type.

Oscilloscope Checks

If the electrician happens to have a cathode ray oscilloscope available, defective stacks can be located readily. First of all, it *must* be established that the rest of the eqipment is functioning normally, and particularly that the three secondary voltages are approximately equal with the rectifier partially loaded. This partial load should be maintained while checking the rectifier stacks.

The oscilloscope, with sweep frequency set to synchronize with line frequency, is first connected across the D.C. output terminals. The pattern should show three bumps (if the circuit is of the Y-connected type) or six bumps (if the circuit is of the bridge or center-tap type) of approximately equal height and shape. (See Fig. 33) If the pattern is distorted—for example, one or more bumps missing—or shows a sine wave, then one or more stacks are defective. (See Fig. 34)

The oscilloscope leads are then removed from the output terminals and bridged across the individual rectifier stacks one at a time, or across individual portions of the stack if it is of the kind which is divided into several sections—always being sure that only a single half-wave element is being bridged by the CRO leads.

In analyzing the resultant patterns, it should be remembered that a properly functioning half-wave rectifier element has a low resistance in the forward direction and a high resistance in the reverse direction. Therefore, the expected pattern would show a half-sine wave corresponding to the voltage drop across the rectifier when impeding reverse current flow, and a horizontal portion, or a very shallow reverse curve corresponding to the voltage drop from forward current flow. Whether the flat portion of the pattern precedes or follows the bump depends upon the phase relationship between the element which is being checked and the sweep frequency in the CRO. The CRO is operated from one of the three phases and the bump will necessarily shift, depending upon which phase corresponds to the element under test.

Furthermore, the bump may point up or down, depending upon the polarity of the oscilloscope leads to the rectifier element. The patterns shown in Fig. 35 all indicate normal stacks.

Fig. 36A shows the extreme condition of a short-circuited stack—i.e., little voltage drop in either direction—and Fig. 36B shows the extreme condition of an open stack—a sine wave corresponding to high resistance in both directions.

Notes

From the foregoing exposition, it should not be assumed that, in order to use rectifier equipment, it is necessary to purchase also a wide variety of electrical test equipment and to retain the full time services of a first-class electrician. The discussion on trouble-shooting is intended to help your maintenance man or electrician achieve a better understanding of rectifier equipment which may be valuable in planning the original installation.

Good installation is the key to low maintenance!

Reducing Hidden Costs Through Labor Relations

By O. C. Cool, *Director, Labor Relations Institute, New York.*

REDUCING labor costs without reducing wages is a management "must" for 1948. Such costs fall naturally into definite categories. The first and most obvious is that of *direct money wages,* which includes base wages, skilled differentials, merit rate ranges, bonus incentives, overtime and the like. *Fringe benefits,* a second natural grouping, includes such labor costs as paid holidays and vacations, hospitalization and other insurance, sick leave, severance pay, profit sharing and pension plans, etc. Both these types are measurable and easily accounted for on the books—but neither of them is susceptible, at the present time, of any marked reduction.

There is a third category, however, within which management *can* bring about definite and worthwhile economies. I refer to the so-called *"hidden costs,"* the ones which do not figure as costs on the payroll, and for which there is no item on the profit-and-loss statement. They include such drains as excessive time spent in training, due to improper selection of employees; time consumed in grievance handling; the costs of turnover and absenteeism; manhours lost through illness and accidents; low efficiency traceable to poor morale; bad work habits; time losses due to lack of instruction or improper maintenance; the time consumed in long-drawn-out negotiations with unions, plus many others almost too numerous to mention.

If there were no other justification for a well-rounded labor relations program, this one objective of reducing or eliminating such costs would be sufficient to make the effort worthwhile. Every one of the conditions mentioned is an obstacle to efficiency, so the net effect of their removal or mitigation is *lower unit cost through improved production.* In short, the treatment pays for itself directly as well as indirectly.

To be specific, here are some of the things that can be done to reduce the burden of hidden costs:

Excessive Time Spent in Training

Where this involves the number of new employees added, the fault most often lies with the personnel department, being traceable to improper selection. Sometimes the latter is due to the fact that hiring is not being done by qualified persons. In other cases, the hiring procedure is at fault. Job descriptions may be inaccurate or absent altogether; the application form employed may not be designed to elicit all the needed information; the aptitude tests may be inadequate or even wrong.

More basic still, the fault may lie with the type of people who apply for jobs—which in turn may be due to unfortunate community relations on the company's part. There are cases on record where excessive turnover and resulting high-cost training were reduced through better recruiting methods—tied in with intensive local public relations to "sell" the employer to the community. One of the lowest rates for annual induction cost belongs to a company which gives job priority to applicants brought in by present employees. Its records prove that such recruits tend to remain longer wih the firm than those attracted by "help wanted" advertisements. Of course, this company's labor relations are "right"—or it could not depend on such methods.

Selection is also a factor in training present employees for better jobs. The worker who is poorly equipped to handle a task involving a higher or different skill should be screened out before training begins. This condition arises most frequently where *job analysis*—especially experience rating—falls down. A keen study of the experience necessary for a job means a great deal, whether it be for recruitment or upgrading purposes. The same is true of aptitudes and abilities, such as the coordination of sight or other sense with physical movements, ability to manipulate small parts or devices, etc. Training can not be expected to fit the round peg for the square hole.

If the nature of the plant permits, training costs can frequently be pared by so rating and scheduling jobs that the work an employee does today may prepare him for the higher job tomorrow—or next year. Supervision of the right sort, which always has an eye for the manpower squeeze around the corner, can go far to reduce time and effort devoted to extra training.

Excessive Time in Spent in Grievance Handling

Most companies do not spend *enough* time settling grievances, in the sense that employees are not given sufficient opportunity or encouragement to air their resentments. However, there are also many companies where grievances take up more time than necessary—either due to a poorly organized system or to wasteful abuse on the part of shop stewards privileged to file employee grievances. Every employer should keep track of the time spent by stewards in handling grievances. If the union shares the cost of such activities, through a contract clause which limits the company's payment for time so spent, the stewards are more apt to streamline their participation.

Permission to settle grievances is not authority to wander all over the shop or to turn a five-minute discussion into a lengthy conference. The Institute recom-

mends the use of a Grievance Time Record maintained by the foreman or supervisor in each department, giving the date, hour and duration of each occasion—thus recording how much time the steward spends away from his bench or machine. It is also sound practice to include in the union agreement a proviso that the stewards be limited to one for each department, and that they obtain the foreman's permission before leaving their work to handle a grievance.

Time spent in other union activities can also constitute a "hidden cost." Most unions require that certain delegates attend conventions and other meetings, while there is also a certain obligation of the employer to give union officials time off without pay to attend to union business. It is well to have a clear understanding on such points before giving blanket permission.

Absenteeism and Turnover

While considerably below wartime and reconversion averages, these still constitute a definite burden. Full employment itself is partly to blame: new jobs are easy to get. Marginal workers are another cause: they have a casual attitude toward employment, often preferring to "lay off" now and then rather than build up a good attendance record. Discipline is not the complete answer to such cases—but a lack of it, due to over-tolerant disregard of abuses, is bound to have a cumulative effect on the work-force as a whole. Unexcused absence or tardiness, too often compounded, should be punished by suspension or discharge.

During the war years, effective use was made of employee interviews to find the reasons underlying high absenteeism and turnover. For example, a worker reporting late was required to see the plant manager or superintendent, and the causes brought to light were corrected, if possible. The exit interview, mandatory upon the resigning worker, had a similar purpose and effect. Dissatisfaction over a foreman's attitude, or over conditions in the plant, led to changes that kept other workers loyal.

Sickness and Accidents

Industrial medicine is making great strides, but the fact remains that thousands of plants are without a medical director, or even a nurse. Some communities are attacking the problem through local foundations and clinics, with the cost underwritten by participating employers. In others, local hospitals are adding industrial health departments, often with the encouragement and sponsorship of the Chamber of Commerce or the Manufacturers' Association. In addition, both state and federal governments are paying increased attention to the need for reducing illness and accident due to work hazards. Trade associations are also giving greater heed to these problems.

A plant-wide Health and Safety Committee, made up of employees representing various departments, is a proven device for eliminating hazards, as well as for keeping check on plant housekeeping, lighting, ventilation and other working conditions. Awards for excellence help to keep interest at a peak, especially if well publicized in the employee publication and the local press. Into such a program additional devices like voluntary health examinations, cold prevention programs and other activities dovetail without the resistance which might otherwise be encountered. *Caution:* ALWAYS offer health tests, injections and similar projects on a purely voluntary basis.

Bad Work Habits

Early quitting and late returning at lunch hour; early quitting at night; overstaying rest and relief periods, and taking excessive washup time—these are a few of the cost-provoking abuses which employees easily slip into, but which can be eliminated by a return to reasonable plant discipline. Last year's portal-to-portal frenzy did help for awhile by focusing the spotlight on badly located washrooms, time clocks and entrances—which in themselves were a *cause* of non-productive time. Not all of these facilities have been moved to better spots; a little more thought to employees' convenience might reduce abuses.

Setting a good example is one of the best ways to handle such situations. There is little use penalizing a worker for washing ahead of time, if the foreman in his department "gets away" with a similar infraction. When office employees are allowed to leave before the production workers, they may have all exits from the parking space blocked when the plant force gets out—which may lead, first to a race and then to a feud. The executive who disregards the no-smoking rule and rides on the freight elevator only justifies others in aping him.

"Visiting" and "walking around" are other time-wasters which every supervisor worth his salt can overcome. Often they trace back to favoritism, or to the pre-LMRA period when only workers were allowed "free speech." All too many times, the provocation was deliberate, in an attempt to get the foreman on the record as "abusive" or "against the union."

One of the best safeguards against lax or improper work habits is a clear understanding between management and the employees, via the union contract, as to what the lunch hour, rest period and wash-up time are, and as to behavior which is subject to discipline by the employer.

Time Lost in Waste and Spoilage

Insofar as these losses are due to lack of instruction or to improper maintenance, they are susceptible to correction through better labor relations. The *material* cost through spoilage is often less than the cost of work-time involved—and the "hidden cost" skyrockets if the interruption spells delay and consequent pay-loss for other workers in the production line. The alert supervisor can do much to minimize and prevent such occurrences.

Low Efficiency Due to Poor Morale

The difference between an efficient, low-cost plant and an inefficient, high-cost plant will often be found in the cooperation and teamwork of the former and the indifference and inefficiency in the latter. The experiments conducted during the war by various companies operating two or more plants—very often with

identical material and wage costs—proved that the so-called "intangibles" of good labor relations were the reason for the good showings. Actually, they are not "intangible" at all: there is nothing more real than friendliness between managers and managed. Good human relations transcend all the obstacles, however solid the latter can be. A genuine desire to solve problems often dissolves the differences that produced them in the first place.

There is no excuse for inefficiency due to poor morale—because there is no excuse for poor morale. The right kind of spirit on the part of the workers is as much the responsibility of management as the right kind of product. Both are largely a matter of controls, as the foregoing paragraphs indicate.

Time Lost in Negotiations

It is easier to blame the union representatives for protracted, long-drawn-out negotiations than to take an inward look—and blame oneself for delays due to lack of information on the spot, or on insufficient preparation of management representatives before the meeting took place. Bargaining is more than agreeing on principles and policies. Every union demand ultimately costs *something* in dollars and cents. How much will two added holidays cost? A five-cent increase in the basic wage? Or a new shift differential? What is the difference, in payroll deductions and retirement value, between a trusteed pension plan and an actuarial plan? Will the proposed incentive plan raise take-home pay, and by how much? What is the impact of higher freight rates on the company's profits and selling prices?

Facts . . . facts . . . and more facts! Tenacity of opinion is no substitute for information. That explains why more and more controllers of large companies are being named to negotiation committees, and why many more are devoting increased time to the development of factual material.

More and more companies are learning, too, that negotiation is an art, as well as a performance required by law. They have seen how the unions with which they deal are represented at the bargaining table by *professionals in bargaining*—men who do nothing else, all year 'round, but conduct negotiations with employers. Small wonder that such firms are relying more and more on professional negotiators of their own—skilled men who have watched all the major demands originate and develop, and who know the hidden pitfalls that often lie beneath a casual approach.

When not caused by the need for additional information—often as helpful to the company as to the union, or more so—stretching out negotiations may be a matter of strategy on the union's part. Alertness on the management side may shift the advantage. After all, no one has a monopoly on timing.

There are other "hidden costs," beside those discussed in this article. New ones arise, and older ones disappear, but all are symptoms, rather than causes. Show me any situation which is obstructing normal teamwork between employer and employee, and I will show you a basic misunderstanding, or a fundamental inability to see two sides of the question—whether the bias be on the employer's side or on the employee's.

Just as a cost accountant or an auditor can sum up a company's financial condition by checking into certain figures on its books, so can the competent labor relations counsel "audit" the efficiency and cooperativeness of the work-force. Looking at the people themselves, and watching them perform their duties, he puts his finger on costs that the accountant cannot see, and which are difficult to measure in terms of dollars and cents. That is why, in accounting terminology, they are "hidden" costs—although, to the labor-relations-minded, they are seldom hidden!

ANODES—PART II

(*Continued from page* 66)

since the anodic current density determines the ratio between the chromic acid and chromium chromate contents of the electrolytes required for satisfactory operation. If the anodic current density is correctly maintained, the trivalent chromium compounds are anodically reoxidized to chromic acid.

If, due to insufficient anode area, the anodic current density is too high, the oxidizing effect decreases accordingly. The chromium chromate content of the electrolyte then increases beyond the critical maximum, causing a corresponding decrease of the throwing power of the electrolyte. When ever this point is reached it is necessary to increase the anode area sufficiency to ensure a satisfactory ratio between the chromic acid content and the chromium chromate constituents of the electrolyte. Under normal operating conditions the chromium chromate content should correspond to a Cr_2O_3-content of about 1 oz./gal.

It is practically impossible to state a definite ratio between anode and cathode area serving all ordinary chromium-plating conditions. The anode area should never be less than the cathode area, but the ratio is sometimes increased to 2:1 or even 3:1 in favour of the anode area.

If under certain operating conditions an excess of chromate has formed in the electrolyte in spite of all precautions, the electrolyte must be oxidized after a certain time. This operation cannot be effected by adding oxidizing agents but requires electrolytic working with oversized anode areas and with copper strip anodes of small area. The anode current density should for this purpose amount to 10 amp/ft^2, at an operating temperature of 50-60° C. The oxidizing treatment usually lasts two or three days to bring the elecrolyte back to saisfactory operating condition. Good results are obtained if the copper strips are introduced in porous membranes filled with chromium electrolyte.

Electropolishing—A Survey (Conclusion)

By Samuel Wein, *Consultant, New York, N. Y.*

The first part of this article appeared in the February issue, and traced the chronological development of the various electropolishing solutions. This concluding article is a practical discussion of the applications and limitations of the process and baths.—Ed.

CONSIDERABLY before 1937, the Battelle Memorial Institute began an extensive research and development program on methods of application of electropolishing to ferrous and nonferrous metals which could be used in manufacturing. Sulphuric-phosphoric, sulphuric-phosphoric-chromic, phosphoric-chromic acid baths, and sulphuric-arsenic acid baths with and without phosphoric acid were developed for many of the commonly used metals and alloys. Shortly after this program was initiated, several of the steel companies began development programs, principally directed toward stainless steel polishing. Allegheny-Ludlum proposed the phosphoric acid bath of Western Electric Co. Rustless Iron and Steel Division of The American Rolling Mills Co. worked with the sulphuric-citric acid process. The Aluminum Company of America related its activities to aluminum. Sulphuric-hydrofluoric acid baths were developed by Blaut and Lang, who were associated with Lucius Pitkin Inc., where sulphuric-phosphoric acids were investigated for stainless steel.

Having practical aspects, the results of the industrial investigations were patented. Beginning in 1937-1938, there was extensive patent application interference, particularly on sulphuric-phosphoric acids and on methods for using them. This pair of acids is the most practical and widely useful. The patent interference lasted for about four years and delayed commercialization.

This patent interference was settled in 1942 and by the end of 1945 the total number of patents issued was brought to over 75, covering most of the basic electropolishing baths having commercial possibilities. There were numerous isolated efforts related to individual studies, principally directed toward metallographic and theoretical studies.

Publications on commercial interest and discussion of possibilities were extensive in 1940 and 1941; so were misunderstandings of the industrial prospects.

Commercialization was again further delayed by the war. Applications could relate only to war material production and essential civilian goods. A number of very important contributions were made in solving specific war problems in manufacturing technique and in improved product performance, and electropolishing methods were greatly improved.

Since the 1940-1941 scramble to get the electropolishing jump, the general perspective is better balanced, and the advantages and limitations are more apparent at the present time.

Limitations and Advantages

Electropolishing is now a commercial process for surfacing, machining, or finishing metals, either to provide a brilliant surface appearance, or to achieve machining without cold working or heat effects and the attendant distortions that accompany mechanical metal finishing methods.

The most outstanding advantage is the production of brilliant color having exceptionally attractive tone not heretofore seen on many metals in simple and complicated shapes. This is accomplished by dissolution of metal from the surface of the work that is made anodic in acid (and occasionally alkaline) solutions. Metal is removed under highly polarized and pseudo-passive conditions which do not prevail in the simple electrolytic cleaning treatments that were generally known in the prior art. Recessed surface areas are polished, as well as relief areas. This effect, along with the exceptional color tone that results, provide the outstanding advantages. The same effect reacts against the process in certain possible applications. Being electrolytic, it is dependent on the surface smoothness and on the physical and mechanical nature, and the "inherent cleanliness" from any particular method of fabrication. Seams, dirt, slag and non-metallic inclusions, deep rolling or drawing lines, and certain insoluble phases in alloys are uncovered and may not be removed.

At the present time, evaluation of practical applications generally originate from a desire to replace hand polishing and buffing. This attempt too frequently fails because proper considerations have not gone into the thinking. One must recognize and immediately accept the fact that there is no "electrolytic wheel finish". The method does not have the cutting and burnishing action of wheels and tumbling barrels, hence, it can never produce the same finish. In view of this, it is obvious that there are applications where mechanical polishing cannot be replaced by electropoishing. Suitability can be determined only on the basis of whether the results are acceptable in their own right. One should never judge electropolishing on the basis of whether it duplicates a wheel finish.

The largest factor in determining acceptance is that intangible one, the human element, and public opinion on "just what is a polished surface". Prejudice, habit, and sales propaganda have established the position of the bright mirror finishes as supposed evidence of quality, because such finishes are expensive to produce by mechanical means. The flexibility of the process makes it exceptionally suitable for treating surfaces having such a

shape that they are not acceptable to mechanical methods.

Since brilliance, unusually attractive and clear color, and some smoothening are easily accomplished, many articles, formerly left dull, can now be dressed up to improve customer appeal. Where the burnished appearance of a wheel-colored surface is required because of custom and habit, a combination of electropolishing plus a light wipe on a coloring wheel accomplishes the result at less over-all effort.

Many automatic and hand operated machines now in use for different kinds of metal surfacing operations can be replaced or complemented. Among these are: machining to exact size, removing of burrs from stamped, ground, punched, drilled edges, etc; surface preparation by polishing and buffing before final finishing by electroplating, painting, lacquering, japaning, enameling, etc. It might as well be called electromachining, electrobuffing, electrodeburring, etc. New avenues in design are opened up and processing operations can be simplified.

In determining the value of the process for a number of applications, a variety of products from many different companies have been studied by Crout.[58] These have included automobile bumpers, hub caps, radiator caps and grill work, horn buttons, windshield wipers, insignia, gears, hardware and trim; watch springs, pivots, cases, and gears; refrigerator hardware, trays and shelves; surgical and dental instruments; aircraft and automobile engine spark plugs, piston rings, and valves; cutlery; tableware; vacuum bottles; electric iron covers and sole plates; waffle irons, toasters, and various kitchen utensils; files, saws, reamers, bits, wrenches, pliers, cutters; a variety of aircraft parts; metal milk containers; tubing, wire, wire products, needles; household and cabinet hardware; costume jewelry, watch bands, belt buckles, and luggage hardware; telephone parts; dies and molds; pipe fittings, bath-room hardware, and plumbing fixtures; screws, bolts, and nuts; printing and engraving plates; chemical apparatus and machinery; metal office and home furniture; thread guides for knitting machines; ordnance materials; cigarette lighters; metallic parts for women's purses; electronic tubes.

Over 100 companies, both large and small, are engaged either in pilot plant or production electropolishing or both in the U. S. A. Most are for decorative finishing, but some are solely for machining benefits realized from uniform metal removal without cold working effects and damage therefrom. The largest daily production for electropolishing is said to handle 8000 pieces and has been in operation continuously for years. A smaller unit handles two or three rack loads at a time for five articles per rack in a ten-minute cycle. Production is by one operator who does the racking, polishing, rinsing, and unracking. This application will eventually reach a level of 20,000 per day. The first processing is solely for machining, and the second is for appearance. Both save 30 to 50 percent of the former costs.

Metals that are available today are not always the best that the mills can produce. Acceptance of defects (in the basis metal) that retard applications of electropolishing will not always be necessary and the time will come when one is not expected to accept them. It is well known that defects in the basis metal and rough handing in the stamping, drawing, or casting departments are paid for by extra costs in the polishing department, one of the most expensive units in any plant. The cost saving that is possible by electropolishing permits fabrication with premium metals and under conditions of better die maintenance and forming practise. Expensive hand polishing can be largely, if not completely, eliminated.

Owing to the brilliance achieved, irregularities become apparent in relatively flat surfaces, but not in contoured surfaces or in those broken by design. For best results by electropolishing, stampings must be made from good quality clean metal in cold-rolled sheet or strip from clean rolls. Surface dents and imperfections should not exceed the magnitude of a scratch from a well-dressed, 180 grit wheel. Orange peel and sand-cast surface roughness cannot be eliminated by a practical amount of electropolishing.

A quality finish of uniform appearance is produced by sand blasting before electropolishing. The "texture" hides the physical defects in the metal, and many novel effects are attainable by varying the particle size of blasting and the time of electropolishing. Satin tone to brilliant sparkle finishes are "slick" to the touch, do not show fingerprints, and do not mar easily in service. Such finishes are probably the lowest priced "quality" finishes available to-day, and many two-tone effects are possible.

Cost analysis cannot be based only on the unit operation of electropolishing, but must include the entire manufacturing program. Finishing can no longer be that process orphan which is attached later as a necessary evil after designing and engineering. For best economy and appearance, these two planning and processing phases should be secondary to, not primary, to finishing. Electropolishing must be designed for, if fullest benefits are to be obtained. The product, manufacturing method, and the equipment design and layout must be handled on the basis of those finishing processes that can be lead to the best streamlining of operations.

Types of Baths

PERCHLORIC ACID BATHS:

For breadth of technical applicability, perchloric-acetic acid baths are outstanding. More metals can be polished with this pair of acids than with any others. Current density range is wide, but tank voltage is very high. Rates are slow, and there is a known explosive hazard. Nevertheless, commercial installations have been considered and operated.

PHOSPHORIC-CHROMIC ACID BATHS:

Baths of phosphoric-chromic acid have almost as universal polishing nature as the perchloric-acetic baths. They are lower in cost than the latter, but have relatively high cost compared with those mentioned in the following paragraphs. Brass, nickel, copper, stainless steel, steel and zinc can be electropolished under practical conditions. Except for brass and zinc, these metals and many of their alloys are more economically polished in other solutions.

SULPHURIC-PHOSPHORIC ACID BATHS:

For practical applicability, sulphuric-phosphoric acid baths are the most useful and in widest commercial application for stainless steels, carbon steels, low alloy steels, nickel, Monel, nickel-

silver, wrought aluminum, and aluminum alloys.

SULPHURIC-CITRIC ACID BATHS:

Stainless steels are also electropolished commercially in sulphuric-citric acid and in plain phosphoric acid baths.

COMPLEX PHOSPHORIC BATHS:

Specific local installations have been developed for baths using phosphoric-acetic, phosphoric-glycerine, phosphoric alcohol or glycol, and sulphuric. The reasons for this are the same as those behind the use of special, local plating bath formulas, although better ones may exist.

FLUORIDE BATHS:

Fuoride and alkaline solutions are in use for aluminum.

ARSENIC ACID BATHS:

The arsenic acid baths tend, during use, to plate out arsenic on the cathodes in a loose form that flakes off and floats. The extent of such reactions depends on the balance between electrode areas, temperature, current density, water content, etc. These baths have not been put into commercial operation as yet, since the sulphuric-phosphoric acid baths have superior properties.

Metals for Electropolishing

The stage at which to introduce electropolishing for machining or finishing in any manufacturing program must be especially selected for each case. Also, each application must be separately analyzed as to selection of basis material, result desired, and method that should be used.

STAINLESS STEEL:

Wrought and cast alloys are expensive to polish mechanically, but are easily brought to high luster electrolytically. For economical electropolishing to good appearance, strip, sheet, and wire must be reasonably smooth to start with. A good grade of 2-B finish on sheet and strip for stamped articles generally provides acceptable appearance after 5 to 15 minutes electropolishing. The stock must be essentially free from slag stringers and rolling seams. Material with No. 1 mill finish can be made very lustrous, but due to the vestiges of pickle pits not rolled out, a "pebbly" appearance results. Little, if any, advantage is gained by electropolishing items stamped from No. 4, 5, 6 or 7 mill-finished material.

Castings, as they come from the mold, must be pickled to completely remove scale and then have parting lines, gates and projections removed. Although very brilliant after electropolishing, the surface texture will be that of the mold surface. Maintenance of cleanliness will be easier in service, since microroughness has been eliminated. The part will be "slick" to the touch. Castings should not be coarsely crystalline or crystalline appearance will result. Carbides, generally, should be properly in solution. High-carbon refractory alloys require special recipes for polishing baths.

Stainless steel types 403, 410, 430, 446, 302, 304, 309, 316, 321, and 347 can be electropolished in the same sulphuric-phosphoric acid solution. The most generally used, 430, 302 and 316 are electropolished under the same conditions of operation which will also polish carbon steels and certain low-alloy steels. A current density of 250 to 500 amps. per sq. ft. would be used in 40 to 43 percent sulphuric acid—40 to 46 percent phosphoric acid bath at 180 to 200° F. The detailed conditoins to be maintained are specific gravity and viscosity, according to the amount of use of the bath and to the work movement during electropolishing. With proper adjustment of viscosity, polishing can be done at current densities up to at least 5000 amps. per sq. ft. Tank voltages should be under 12 volts and a 14 volt direct current source is used. The bath costs about $1.00 per gallon, on the average.

Better throwing power in the range of 250 amps. per sq. ft. is obtained in 15 to 20 percent sulphuric acid, 63 to 67 percent phosphoric acid baths, operable at 50 to 500 amps. per sq. ft. at 110 to 130° F. These conditions are applicable only to austinitic types of stainless steel, high-nickel alloys, and certain nickel-cobalt and nickel-cobalt-chromium alloys. The baths would cost about $1.25 per gallon.

Another process for stainless steel comprises a solution containing 55 to 60 percent citric acid; 15 to 20 per cent sulphuric acid, 20 to 30 percent water, and an amount of alcohol.[59] Processing is for 5-10 minutes at 75 to 145 amps. per sq. ft. at 6 to 8 volts. The bath would cost about $1.35 per gallon.

These stainless steel baths are handled in lead lined equipment.

During operation, salts precipitate a portion, but not all of the metal dissolved from the work. Therefore, specific gravity and viscosity control are needed in addition to adjustment of total acid and either sulphate-phosphate or sulphate-citrate ratio. Drag-out should be permitted to remove a portion of the used bath, so it can be replaced with fresh bath.

Kiefer[60] used 4 parts conc. phosphoric acid to 1 part of water at 1 to 12 amps. per sq. in. at low temperature. Four minutes at 2-3 amps. per sq. in. is the preferred range at 12-25 volts for irregular shapes. At some conditions, 4-6 volts is possible. Brilliance of luster is not so good as in the other baths and ageing effects of continuous use are more pronounced. Operating costs are higher than for the previous types of baths.

CARBON STEELS AND ALLOY STEELS:

Steels in this classification are electropolished for machining, for burr removal, and in preparation for plating, painting, and vitreous enameling. Low carbon steels, such as S. A. E. 1010 and 1020, can be smoothened and made very lustrous by electropolishing, but not to the degree attained with stainless steel. Generally, the appearance is not improved greatly because of the non-metallic inclusions, seams, orange peel, etc. No. 1 cold-rolled steel can be stamped, and formed, then electropolished to shorten hand polishing to one coloring wheel. Better practice is to use No. 3 high quality cold-rolled steel, blank, form, and either copper or nickel plate then electrobuff the plate as discussed later, under copper and nickel.

S. A. E. 1040, 1060, 1085, 4130, 4140, 52100, Nitralloy, nitrided steels, and carburized steels electropolish to high luster. Excellence of appearance depends on the quality of the steel. The principal advantage is for surface preparation before plating for engineering purposes where strong bonds are required. Since surface stressed metal is removed and non-metallics cleaned out, improvement can be obtained in corrosion protection offered by plated coatings.

The only commercial methods for

these metals that have reached the writer's attention are based on sulphuric-phosphoric acid baths, 40-43, 40-48 per cent composition.[61] The conditions shown for stainless steel polish the carbon steels and low-alloy steels. The surface becomes clean and brilliant. Current densities range from 125 to 500 amps. per sq. ft. at 115 to 200° F. At proper specific gravity, viscosity, and cathode current density, operation is continuous with ferrous sulphate precipitation. Drag-out losses take care of concentration build-up in other metals.

Dilution of the polishing bath during rinsing might cause staining. If staining cannot be avoided, chromic acid may be used in the polishing bath, which is also then applicable to special tungsten and molybdenum steels. Parts for chromium, bright nickel, bright copper, and other plating can be electropolished, using commercial methods immediately after the rinse following electropolishing. Adherence is excellent; in fact, bright cold-rolled steel that is eelctropolished for 15 seconds can be bright nickel plated directly after rinsing.

WROUGHT IRON AND CAST IRON:

No successful applications for electropolishing these have come to the author's attention.

NICKEL:

For decorative finishing, electropolishing of nickel plate offers outstanding possibilities. Purity and structure control of the metal-to-be-electropolished is then in the hands of the finishing department. Good results are not dependent on nominal specifications set down for mechanical reasons of fabrication ease, whims, or otherwise. A single electropolishing method is then available for different metals if they can be nickel plated. If surface defects in the basis metal are kept to a magnitude not exceeding that of a scratch from 180 grit polishing wheels, satisfactory appearance is realized by applying an *excess* plate thickness of 0.0001" to 0.0005" and electrobuffing it off. The nickel gives "hiding" power, and the electrobuffing gives additional "color insurance" for occasions when the brighteners in bright baths may be slightly out of balance. This latter process might appear to be "gilding the lily", but in many cases may be justified in maintaining even production on critical items, such as drawn parts where direct bright nickel plating alone does not have the clear brilliant color desired over the as-formed surface. In this case a short "electrobuffing" treatment improves the "color tone" and causes acceptable appearance.

In considering this procedure, it must be remembered that electropolishing has better throwing power than plating, so the area of thinnest plate is the basis of processing calculations. Corrosion protection offered in a salt-spray test is not reduced by electrobuffing bright nickel plate provided the specified plate thickness remains.

Watt's or gray nickel plate requires l o n g e r electropolishing time than bright nickel plate, and wrought nickel requires still longer. The latter requires 10 to 20 minutes compared with 1 to 2 minutes for bright nickel plate, which, for maximum benefits, may be polished for as long as 10 minutes.

There are at least two practical methods. Seventy three per cent sulphuric acid solution is operated at 250-560 amperes per square foot at 85° to 140° F, according to Hotersall and Hammon.[62] During operation, nickel sulphate precipitates almost immediately in the bath. The acid concentration is critical and the current-density range is narrow. There is always a possibility of precipitation of salts at high current-density points on the work. The bath costs about $0.18 per gallon.

Broader operating ranges and less critical control are required of 15 per cent sulphuric—63 per cent phosporic acid solutions.[72] Electropolishing is done in 1 to 20 minutes at 50-500 amperes per square foot at 80° to 220° F. Preferred conditions are 200 amperes per square foot at 115° to 130° F. with continuous control by precipitation of nickel sulphate (not at work surface) or by plating nickel on the cathode at the same rate it dissolves from the work. Continuous operation involves only specific gravity adjustment according to hydrometer measurement and infrequent analysis for acid-ratio balance. The bath costs $1.20 per gallon, but the cost of chemicals is only that associated with drag-out loss, and thus is reasonably low. Nickel is recovered on the cathodes and can be re-used as plating anodes. Otherwise, it is scrap of 95%+ purity.

COPPER:

What was said previously about nickel plate electrobuffing can be said also for copper plate. Bright copper and semibright copper plate are electrobuffed in shorter time and with more favorable results than matte copper, as from the acid copper sulphate bath. Exceptional results can be obtained by applying an extra 0.0002" to 0.001" of plate and electrobuffing it off as means for supplanting hand polishing of basis metal and buffing of the plate. After electrobuffing copper plate, 0.0002" of bright nickel plate is usually deposited before chromium plating for full color.

Numerous solutions have been used for electropolishing copper at one time or another in attempts to find commercially practical methods. Phosphoric-alcoholic, phosphoric-acetic mixtures, and just phosphoric acid have been used with mediocre success. The organic agents are volatile and expensive, and the phosphoric acid bath requires temperatures lower than maintainable without refrigeration in the summertime, and it also becomes exceptionally viscous.

A modification of phosphoric acid [63] permits acceptable, brilliant polishing at 200 to 300 amperes per square foot at 120-140° F. in a continuously operable bath requiring only specific gravity control, occasional replacement of drag-out, and infrequent analysis. Copper plates out as a fine powder on the cathodes to prevent metal build-up of the bath during operation. The powder is less than 10 microns in size and makes good powder compacts. The bath costs about $1.75 per gallon.

Wrought and cast copper are made very lustrous, but generally have a faint pebbly "texture" associated with the effect of relatively coarse structures. Oxides in the copper are particularly troublesome, and lead produces pits or "peaks".

Electropolished copper can receive "Electrocolor" treatment to show exceptionally clear, rich color effects not attainable on wheel-buffed copper.

BRASS:

All of the comments that have been made about the cleanliness and surface smoothness of wrought alloys also pertain to brass sheet and strip. Dirty rolls cause trouble by embedding material in the surface or by making pits.

The best results by electropolishing are with cartridge brass and gilding metal (95-5) half hard. All compositions of copper-zinc alloys from yellow to pure copper can be electropolished under the same conditions. With brass that has had the best melting and rolling practice, a brilliant mirror-like surface can be obtained, with no wheel work, which can then be bright nickel and chromium plated for customer products.

The methods named for copper will polish brass to a mild degree but not to a brilliant mirror-like luster.

Both brass and copper are electropolished equally well in a phosphoric-chromic acid bath at 130-140° F. at 250-350 amperes per square foot. The other process for copper costs very much less, therefore it is preferred. The brass bath costs $1.80 per gallon and has a high cost for use, since it has a finite life.

The above bath will not satisfactorily electropolish leaded brass. The leaded phase is relatively little attacked so the surface becomes frosty and rough to touch.

MONEL AND NICKEL SILVER:

These two metals are polished with commercial facility in the sulphuric acid-phosporic acid bath used for nickel. Slightly higher current density is required. General factors relating to sheet, strip, castings, etc. also pertain. Mixed use of a bath for pure nickel and these metals is practical, but large use on nickel should be reserved for that metal alone for the best economies.

ALUMINUM:

Mirror-like finishes of exceptional light reflectivity are commercially produced on aluminum. There are several patented methods, but the procedures have not been made public other than as disclosed by the patents.

Sulphuric-phosporic-chromic acid bath will electropolish such wrought aluminum alloys as 2S, 3S, 14S, 24S, 51S, 53S, and 64S. Current densities range from 100-2000 amperes per square foot; preferred is 100-150 amperes per square foot at 12-15 volts at 180 to 200° F. Owing to the tendency of aluminum to anodize, careful control of viscosity and specific gravity is required. Charts have been worked out for this. Aluminum metal stays in solution, so a given bath without loss by drag-out and replacement thereof has a finite life.

As-rolled, drawn, or extruded stock can be electropolished to mirror-like appearance by a 3-10 minute treatment. Handling care is important in rolling, drawing, or extruding, so that dirt is not embedded to later cause pits, or so that deep scuff marks are not made.

Die-cast alloys, particularly those containing silicon, are not polished well by the method referred to above.

Electropolished aluminum acquires an unusually rich color tone when anodized and dyed afterward. Anodizing can be accomplished without appreciable decrease in as-electropolished brilliance. Anodizing is needed for good salt spray and high humidity resistance, although as-electropolished metal has remarkable resistance to tarnishing and staining.

ZINC:

Commercial electropolishing of zinc and zinc die castings has not come to the author's attention. Electropolishing of electrogalvanized wire and thin strip should be commercially interesting and practical. Brilliant, mirror-like finishes are produced on pure zinc and zinc plate[74] in caustic solutions, caustic-cyanide solutions, chromic-phosphoric acid, and perchloric-acetic acid solutions. Several of these are commercially feasible, but very little interest has been shown by producers or fabricators for polishing pure zinc.

The last named bath presents extreme hazards, and therefor should not be considered for commercial practice.

CADMIUM:

This metal can be electropolished in acid solutions that are under development but which are still in the laboratory stage. The only potential application now visible is for brightening plates, and very little interest in that has been evident thus far. A chemical polishing bath for cadmium plate is reported, based on acetic acid-iodide solution.[64]

SILVER:

Silver was the first metal to be electropolished with an expressed commercial interest. Reference is made to the German patent of 1910. Apparently the process was never commercialized. All platers from time to time have noticed periodic voltage fluctuations in their silver tank and have seen bright anodes result. There are recent publications on polishing silver in cyanide baths according to Gilbertson and Fortner.[65] The method is slow. No method has been found to electropolish sterling silver by the author.

LEAD, TIN AND THEIR ALLOYS

These metals are electropolished in perchloric-acetic acid solution for metallographic examinations, according to Jacquet.[66] No commercial applications have been recorded to date, due to the explosive nature of the baths when not properly operated.

MAGNESIUM:

Pure magnesium can be electropolished to mirror-like appearance in phosphoric-chromic acid solution, but there is practically no application for it. Die castings do not respond to the same conditions as the pure metal, and satisfactory procedures apparently have not yet been developed. Successful polishing and plating of magnesium die castings will open a large market for the product.

Electropolishing Operating Data

CATHODES:

The cathodes may be of stainless steel, lead, copper, graphite, duriron or other conductive, insoluble materal, about 10 to 20 times the area of the anode (parts). Incidentally, where many objects or parts of the same intricate shape are to be polished, conforming cathodes that have the same general shape as the parts should be used. This promotes uniform smoothness down into the recesses. In special cases auxiliary cathodes may be used.

ANODE-CATHODE DISTANCE:

The article to be polished should be totally immersed in the electrolyte, as the foaming in some solutions results in a poor polish on that portion within the foam; furthermore, attack on the metal at the solution line is severe. The distance between the anode and the cathode may be from ½" to 5 inches. When the work is coiled (wire or strip) polishing is best done continuously, with the strand being drawn through the polishing solution.

TANKS AND AUXILIARY EQUIPMENT:

The tank set-up for electropolishing stainless steel is not complicated. Simple objects, such as those made with

wire, as well as much more intricate stampings and castings are readily electropolished.

All concentrations of acids encountered in the electropolishing baths and in rinse tanks can be handled in lead-lined equipment. The electropolishing baths of 30% water content or less can be handled when cool for appreciable periods in cast iron equipment. Internal cooling coils and steam heating coils are made of lead. External heating or cooling can be provided by means of heat exchangers.

Chemical lead-lined equipment is most widely used. Certain synthetic resins, such as Polythene, Saran, and Koroseal are resistant to many of the baths in commercial use at temperatures below their softening points. Organic coatings should not be used with Perchloric Acid baths, due to the possibility of explosions.

RACKS:

Racks are most suitably made of copper. Since the copper is relatively slowly attacked, bare racks can be used. However, it is better practice to insulate the racks with an inert coating. The contact part of the work can be bare, or coated with solder or lead. Solder and lead show no appreciable anodic attack in the baths described. Several of the lacquer base coatings have been successfully used for rack covering. Work contact to the rack must be positive and secure, in order to prevent arcing. The same remarks, with regard to organic materials in Perchloric Acid baths, apply here as in the case of tank linings.

Corrosive gases are not emitted, but exhaust fans might be required in certain cases of high temperature operation, in order to withdraw the small amount of spray and separate its liquid component, as is done in chromium plating. Hydrogen and oxygen discharge during electropolishing is less in quantity per ampere hour than in chromium plating and offers a smaller, but anologous problem in regard to spark discharges.

AGITATION:

Electropolishing is readily accomplished in a still bath. A certain amount of controlled agitation gives improved results. Gas discharge during electropolishing in still baths may create a furrow through the "polishing film." Because of the local "film thinning" effect, there is greater efficiency of anodic dissolution in these furrowed regions. Therefore, the surface becomes irregular. Furrows begin at points of gas discharge such as holes, peaks, edges, etc. Furrows and ridging effects are particularly noticeable in aged baths.

Mild agitation is beneficial for three reasons: First, it changes the gas flow from a continuous straight line to an eccentric path. Consequently, there is no pronounced local "furrowing" of the film to cause a ridged, but otherwise polished surface.

Second, in the still baths the thickness of the electropolishing film is determined by (1) the mild agitation resulting from gas discharge and from settling of the heavy anode liquor, and (2) rate of diffusion of dissolved metal into the bath. Therefore, the effect of mild agitation is to improve the uniformity of thickness of the electropolishing film. The processing time is shortened and the uniformity of luster is improved.

Thirdly, mild agitation increases the temperature uniformity throughout the tank.

The simplest and most reproducible form of agitation is secured by an oscillating movement of the work rod. Movement of the work is preferred whenever possible, but some shapes introduce complications. In such cases air agitation of the bath is used to advantage. In a few cases, agitation by a propeller stirrer has been successful. This method, however, yields the least reproducible results if the relative positions of work and stirrer are not fixed.

TIME FOR ELECTROPOLISHING:

The time for finishing a given type of work depends on: (1) the degree of lustre desired; (2) initial surface conditions; (3) current density; (4) temperature; (5) bath composition; and (6) degree of agitation. Economical electropolishing times are in the range of from 1 to 15 minutes. The upper limit of time is controlled solely by the limiting metal thickness loss and costs.

The approximate time required to accomplish a given result is inversely proportional to the current density. Since there is a slight change in current efficiency with current density, the current time relationship is not exactly linear.

The maximum luster is usually reached during the first 1 to 15 minutes of treatment. Longer treating time adds no more to the brilliance of the finish, but secures whatever additional "smoothing" action can be given by the particular combination of factors.

Control

Control problems for the commercially operable methods are easily handled by anyone familiar with plating control. In plating, pH is the most frequent measurement. In electropolishing, specific gravity and viscosity measurements are the most frequently made. Total acid and ratio of component acids are measured and adjusted periodically. As previously mentioned, temperature must be carefully regulated for uniform results. Automatic controls for heat and cooling are favored in commercial installations.

Tarnish Resistance

Electropolishing accomplishes some passivation of all metals and provides improvement in tarnish resistance. The most outstanding benefits are found with the stainless steels, which are much improved over the condition given by the customary nitric acid passivation. Carbon steels stand up considerably better and for longer periods of time without rusting. The evil day does arrive, however, since the metal is still steel. Similarly, brass, copper, nickel, etc., have tarnishing greatly retarded. Aluminum is quite resistant to tarnishing and fingerprinting, but greater resistance is provided by anodizing after electropolishing.

Equipment and Layout

For industrial operation, a polishing tank and two warm rinses are required along with the necessary auxiliary equipment such as cleaner (preferably solvent and vapor method), scale remover, racks, etc., as used for plating. Electropolishing racks must be built to carry higher currents than normally used for plating (except chromium) and to provide positive electric contact. Rack costs are approximately two to three times those for plating. Equipment life otherwise is figured about the same.

Work placement relative to cathodes is similar to that for electroplating. Throwing power of electropolishing is

better than that of acid-plating baths, but cathode placement must be planned for current distribution to the parts, which must be racked so that proper "robbing" is attained from part to part. These relationships are not critical and will be clear to anyone familiar with electroplating. There are specific cases where shape of stainless steel items is suitable for barrel polishing. Promising results have been obtained for barrel electropolishing copper plate on parts which have been barrel plated.

Provision for heating and cooling is desirable for the polishing tank where the current usually is under 10 amperes per gallon and preferably 5 amperes per gallon or less, in order to maintain low voltage and temperature.

Since electropolishing requires work racking and current distribution analogous to electroplating, processing can be done in the same type of automatic, semi-automatic, or manually operated equipment. Thus, electropolishing can be effected at one or more stages in electrolytic finishing or processing setups that also includes cleaning, pickling, rinsing, plating, or anodizing stages.

Costs

The cost of electropolishing a metal cannot be expressed in a few paragraphs any more than can the cost of electroplating a metal. Tanks, equipment, power, auxiliaries, etc., are the same as those for plating, so investment costs, fixed charges, etc. are similar. Polishing solutions have greater weight per gallon, so tanks must be stronger. Tank loads to meet production requirements and current of 5 amperes per gallon make it easy to figure tank sizes and tank current.

Materials are consumed during electropolishing. Metal is removed from the work, generally equivalent to 0.0001" to 0.001" in thickness. This metal dissolves in the bath and must be removed from it; otherwise, the bath ceases to electropolish when it becomes saturated with metal.

Thus, life of an electropolishing solution is one element of cost that has to be considered. Some electropolishing baths have a finite life dependent on saturating the bath with the metal that is dissolved from the work. This life, then, is fixed by the amount of metal that is removed from the products being treated. Other electropolishing solutions have infinitely long operating life. Losses from them amount solely to drag-out. Baths are commercially available for electropolishing copper and nickel, which are maintained in a state of equilibrium during operation, because they plate metals on the cathodes at the same rate as the metal is dissolved from the work. This cathode metal thus becomes recoverable and can be credited to the process. Other solutions, and these include the ones for stainless steel, have relatively long life because they precipitate metal salts from the solution. These salts are removed from time to time, and acids lost in the salts and those lost by drag-out are replaced to maintain operating control.

Tank voltages are generally higher for electropolishing than for plating. Since current densities are higher, electric energy consumption is greater.

The cost of chemicals, the current density range, the tank voltage, the stability of the bath, the breadth of applicability, etc., determines which electropolishing process will be most economical.

Equipment life and maintenance costs are about the same as for plating. In some cases (stainless steel, steel, nickel polishing) rack costs are less than they are for plating. In others, rack costs run two or three times higher. Other costs, such as labor charges for racking and unracking, tank operation, and control are approximately the same as for plating. The direct charges, such as for electrical energy and chemicals, are specifically related to the time of electropolishing, the current, the tank voltage, and the particular bath used.

Total costs per part for production quantities have been estimated from sample work in sulphuric-phosphoric acid solutions. Certain assumptions in overhead, labor charges, etc., were broadly made, so the figures are probably on the conservative side. Cost analysis for specific applications sometimes run higher, and many times are found to be lower for the surface area of the part involved.

On an approximate basis, costs per square foot for electropolishing will be on the order of the following:

Stainless steel—5 minute polishing, 2-5 cents; 10 minute, 5-12 cents; carbon and low-alloy steel—not so directly related to time; 5 to 30 minute polishing should be in the range of 0.1-15 cents regardless of time, aluminum—2 to 15 minute polishing should be in the range of 2-25 cents; brass—5 to 15 minute polishing should be in the range of 5-25 cents; nickel—1 to 7 minut electropolishing, 0.1-15 cents; copper—1 to 15 minute electropolishing, 0.1-20 cents. Unit costs can be obtained, also approximately, according to the number of parts per square foot of surface polished. The important conclusion is that electropolishing applications must be "tailor-fit." Therefore, costs must be specifically evaluated for each case.

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Shop Problems

METAL FINISHING publishes, each month, a portion of the inquiries answered as a service to subscribers. If any reader disagrees with the answers or knows of better or more information on the problem discussed, the information will be gratefully received and the sender's name will be kept confidential, if desired.

Gassing in Electropolishing

Question: When electropolishing stainless steel, a lot of gas forms around the parts. How can I prevent this? W. A. C.

Answer: The gassing around the parts being electropolished is caused by the decomposition of the acid solution by the electric current, and is a natural reaction. While not always desirable, it cannot be prevented.

Nickel Anodes

Question: Can you tell me the difference between rolled carbon and rolled depolarized nickel anodes, and which would be best for my bright nickel solution? C. W. E.

Answer: Carbon anodes for nickel plating contain small amounts of carbon and silicon which form films on the surface of the anode as it dissolves. These films prevent loose metallic particles from falling from the anode as it dissolves and entering the solution, where they could cause rough plating. The depolarized types of nickel anodes contain oxygen as nickel oxide, which also forms films as the anodes dissolve, acting similarly as above. All other things equal, there is very little difference in the behavior of these two types of anodes. For certain proprietary nickel baths, the manufacturers have some preference for one or the other type, and these recommendations should be followed.

Stripping Copper from Zinc Die Castings

Question: We are having trouble removing copper plating from zinc die castings. We have tried the Sodium Sulfide method but it was not satisfactory. Can you suggest any other methods? A room temperature immersion dip is desirable. A. H. A.

Answer: In order to strip copper plating from zinc castings, the following solutions can be used:

1) Chromic Acid 64 oz/gal.
   Sulfuric Acid 7 oz/gal.
2) Sodium Cyanide 24 oz/gal.

If a yellow film exists after treatment in the first solution, a few seconds dip in 10% sulfuric acid will brighten it up.

Stainless Steel Plating Tanks

Question: What type of stainless steel would you recommend for making plating tanks? G. A. C.

Answer: Inasmuch as the tank will have to be made by welding stainless steel sheets, I would suggest using one of the grades made especially for welding, such as type #321 or #347. These steels have been "stabilized" for use in corrosive applications after welding.

Tanks for Gold Plating

Question: We are planning to install a larger gold solution and would welcome your advice on the type of tank that is best. T. D. N.

Answer: Stainless steel tanks or rubber-lined steel tanks are both excellent for gold solutions, but rubber-lined tanks cannot be heated externally as can the stainless steel type.

Cleaners Without Cyanide

Question: We would like to know of some other cleaner that we can use for cleaning parts for plating. Our present cleaner contains too much cyanide to be disposed into the local sewer system. R. G. C.

Answer: There are a number of excellent metal cleaners on the market for plating work that contain no cyanide. For the most part they are made up of soap, tri-sodium phosphate, sodium silicates, borax, and other harmless wetting agents, and they can be used in your reverse current cleaning tank. A list of suppliers of these materials is being sent to you.

Black Coating for Nickel Silver

Question: Can you let us know what solution could be used for blackening the surface of nickel silver tubing? The parts are assembled and cannot be dipped into a tank, so we will need a solution that can be brushed on and the excess wiped off where blackening is not wanted. M. H. I.

Answer: A solution which has been proposed for doing this type of finishing is as follows:

Arsenic Acid	60 grams
Copper Sulfate	60 "
Ferric Chloride	12 "
Copper Lactate	12 "
Ammonium Chloride	6 "
Sod. Thiosulfate	9 "

The solution is wiped on the cleaned and degreased surface, allowed to remain for several minutes, wiped off, and the process repeated until the desired depth of color is obtained.

Standard Solutions for Test Work

Question: How can I make up a Half-Normal solution of Hydrochloric Acid for plating solution analysis? D. H.

Answer: Half-Normal hydrochloric acid can be made by diluting 43 c.c. of pure concentrated acid to 1 liter. For the most accurate work, this solution should be standardized by titrating against pure Sodium Carbonate. Unless adequate laboratory facilities are available, I suggest that you buy these solutions already made up and stand-

ardized from one of the supply houses on the list being sent to you.

Soft Nickel Deposits

Question: What would you advise to soften nickel deposits obtained from a bath of the following analysis?

Nickel Sulfate	8.5 oz/gal
Amm. Chloride	.75 oz/gal

Temperature 35°C, pH 6.4. Air agitated. J. D.

Answer: In order to get softer deposits, you should adjust your bath to the following:

Nickel Sulfate	16 oz/gal.
Amm. Chloride	4 oz/gal.
Temperature	110-125°F.
pH (color)	5.5-6.0

This warm bath at lower pH will give softer deposits. The solution should also be kept free of organic matter and brighteners to avoid harder deposits. Low current densities will also be helpful.

D. C. Power Supply

Question: How can we best convert our regular house current to direct current for small electroplating jobs? D. L. H.

Answer: Probably the most convenient means for doing this would be to use one of the small bench type rectifiers available from a number of manufacturers. These have capacities up to about 400 amperes output, and should be sufficient for a small installation such as you are planning.

Refinishing Old Silverware

Question: How can we remove the pits frequently found on the old pieces of silverware that we get for refinishing. We would like to do this without polishing, if possible. The black residue often found in these pits is very troublesome to remove, and we would like your opinion on this also. R. S.

Answer: I suggest that you first remove any old lacquer films, then degrease thoroughly. The parts can then be reverse current cleaned in a mild alkaline cleaner. The pits can be smoothed out by hammering them flat from the reverse side of the part, then buffing the front surface smooth before cleaning and replating.

Rod Agitators for Plating Tanks

Question: What advantages are to be gained by the use of rod agitators for plating, and how much increase in plating rate could be expected? P. B. G.

Answer: Rod agitators are commonly used to permit an increase in current density and to dislodge small gas bubbles that might adhere to the parts in solutions of low wetting power. The exact increase in plating rate made possible in this way cannot be predicted, as it depends on several factors.

Black Finish on Aluminum

Question: We would like to finish our cast aluminum microscope stage in a dull black color that would be durable. Can you suggest a finish of this type that would be suitable for this application? R. D. G.

Answer: I believe that a black anodized finish would stand up very well for this job. The parts are first anodized, then dyed black, which results in a fairly hard surface. Another treatment you could use would be to first copper plate, then blacken the copper by one of the common blackening methods.

Tungsten Plating

Question: Can you give me the details for the necessary solutions for plating Tungsten over steel? G. R. I.

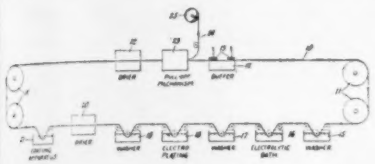
Answer: A method for tungsten plating of steel has been developed by the National Bureau of Standards, Washington 25, D. C. Research Paper RP1834 gives all the procedures and solutions involved.

Patents

Electrolytic Production of Thin Metal Foil

U. S. Patent 2,433,441. *Charles Dividoff, assignor to M. Swift & Sons, Inc.*

A continuous process for the manufacture of extremely thin metal foils, comprising the steps of mechanically



polishing an endless band of stainless steel, thereafter making the polished band the anode in an alkaline electrolytic bath to passivate the band and maintain it in condition for clean stripping, continuously electroplating a thin layer of metal on the surface of the treated band, applying a reinforcing pull-off film forming material in a solvent directly to the thin layer of electroplated metal, drying the film forming material, and mechanically stripping the composite strip of thin metal and film from the endless band.

Electrolyte and Method for Anodically Polishing Nickel

U. S. Patent 2,429,676. *Charles L. Faust, assignor to Battelle Memorial Institute.*

An electrolyte for use in the anodic polishing of nickel comprising from 5 to 85% by weight of sulfuric acid and from 5 to 85% by weight of orthophosphoric acid, the combined content of these acids being at least 50% but not over 90% by weight of said solution, 0.5 to 2.6% by weight trivalent aluminum and 0.5 to 1.4% by weight trivalent chromium, the balance comprising essentially water.

Corrosion Inhibitors

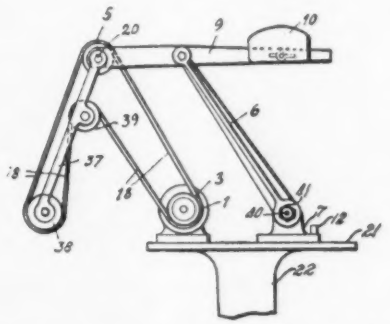
U. S. Patent 2,432,839. *Aaron Wachter and Nathan Stillman, assignors to Shell Development Co.*

A non-corrosive composition of matter comprising a major proportion of an organic material having a pH of at least approximately 7 and coming in contact with water during the useful life thereof, said organic material having dissolved therein in minor proportion, but in amount sufficient to inhibit corrosion of metal surfaces by said water, a nitrite salt of a primary amine in which the amine radical is attached to a secondary carbon atom, said primary amine nitrite salt being substantially stable at atmospheric temperature, soluble in water and in said organic material and normally non-reactive with said organic material.

Abrasive Belt Grinding Device

U. S. Patent 2,433,427. *John Ivar Carlsson, assignor to Rolling Fabriksaktiebolag.*

A grinding device comprising a fixed bearing, a shaft mounted in said bearing, means for driving said shaft, a driving pulley on said shaft, a second fixed bearing, a support pivotally mounted in said second bearing and adapted to be swung in a vertical plane and to be locked in desired position, a lever pivotally mounted on said support, a guide and tension pulley mounted on said lever, an endless



grinding belt running over said pulleys, an arm pivotally connected with said lever, a third pulley mounted near the end of said arm, a fourth pulley mounted on said arm, said belt running from said tension pulley over said third pulley and over said fourth pulley to said driving pulley, said fourth pulley being located substantially between said tension pulley and said third pulley, and an external load on said lever for stretching said belt.

Method of Roughening the Surface of Ferrous Elements

Charles A. Escoffery and Burton Werbel, assignors to Federal Telephone and Radio Corp.

The method of etching a ferrous element comprising treating said element with a solution comprising 50 to 55 parts by volume of acetic acid, 40 parts by volume of concentrated nitric acid and 40 to 55 parts by volume of water.

Method for Cleaning Aluminum

U. S. Patent 2,431,595. *Wayne E. White, assignor to Aluminum Co. of America.*

A method of cleaning aluminum surfaces, comprising immersing the article to be cleaned in a bath containing a predominant quantity of available molten ammonium fluoride for a period of at least 5 seconds, said bath being maintained at a temperature of at least 240° F. and thereafter removing the article from the bath.

Tin-Plating Process

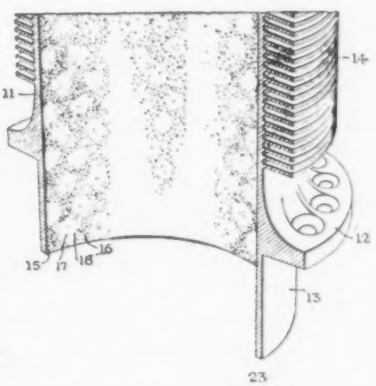
U. S. Patent 2,432,718. *Newell F. Blackburn, assignor to E. I. du Pont de Nemours & Co.*

A tin plating process which comprises electrolyzing with anodes consisting of an alloy of tin and sodium containing 0.1 to 10% by weight of sodium in a water solution consisting of 120 grams per litre of sodium stannate, 21 grams per litre of potassium hydroxide and 120 grams per litre of potassium carbonate, at a temperature of 90° C., an anode current density within the range 100 to 200 amperes per square foot and a cathode current density of not less than 200 amperes per square foot.

Chrome Plated Wear Resisting Surface

U. S. Patent 2,433,457. *Tracy C. Jarrett and Robert D. Guerke, assignors to Koppers Co., Inc.*

A wear resistant bearing member



having a surface layer of electroplated chromium, said surface layer presenting a recurrent pattern in which areas of dense, substantially smooth chromium are interspaced in areas of porous chromium.

Process for Breaking Petroleum Emulsions

U. S. Patents 2,429,996—2,430,003. *Melvin De Groote and Bernhard Keiser, assignors to Petrolite Corp., Ltd.*

A process for breaking petroleum emulsions of the water-in-oil, type characterized by subjecting the emulsion to the action of a demulsifier comprising a hydrophile compound of the formula:

$$R_1O(R_2O)_nOCR_3.N{:}R_4$$
$$\qquad\qquad\qquad\qquad\qquad\quad |$$
$$\qquad\qquad\qquad\qquad\qquad\quad \text{Halogen}$$

in which R_1 is a monocyclic phenol radical having at least 2 and not more than 3 alkyl side chains, of which at least 2 contain at least 4 carbon atoms; the longest side chain of the nucleus R_1 shall not contain more than 8 carbon atoms, with the proviso that the number of carbon atoms in all of the side chains must total at least 9; R_2O is an alkylene oxide radical containing at least 2 and not more than 4 carbon atoms selected from the class consisting of ethylene oxide, propylene oxide, butylene oxide, glycide and methylglycide radicals; *n* is a small whole number varying from 1 to 6; OCR_3 is the acyl radical of a low molal monocarboxy acid having not more than 6 carbon atoms, in which an alpha-hydrogen atom has been removed; and $N{:}R_4$ represents a radical of a heterocyclic compound of the pyridine series selected from the group consisting of pyridine, quinoline, isoquinoline and C-linked methyl homologs.

Removing Organic Impurities from Copper-Cyanide Electroplating Baths

U. S. Patent 2,434,191. *Harry L. Benner and Robert R. Bair, assignors to E. I. du Pont de Nemours & Co.*

The process for removing deleterious organic compounds from a used electroplating bath containing hydroxyl ions and carbonate ions which comprises precipitating magnesium hydroxide in said bath by adding a soluble magnesium salt to said bath and replacing the acid radicles of said magnesium salt with hydroxyl radicles substantially without precipitating magnesium carbonate therein.

Corrosion Inhibitors

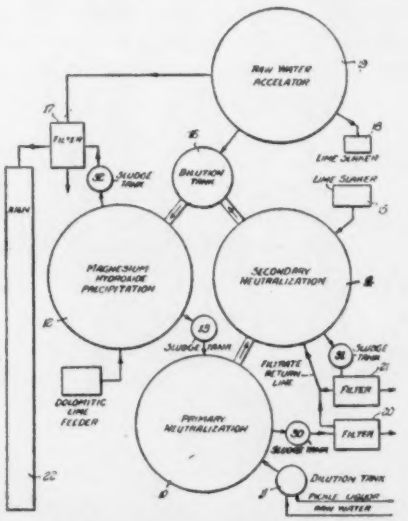
U. S. Patent 2,432,840. *Aaron Wachter and Nathan Stillman, assignors to Shell Development Co.*

A non-corrosive composition of matter comprising a major proportion of an organic material having a pH of at least approximately 7 and coming in contact with water during the useful life thereof, said organic material having dissolved therein in minor proportion, but in amount sufficient to inhibit corrosion of metal surfaces by said water, a nitrite salt of a tertiary ami in which the nitrogen atom of the amine radical is attached to at least one secondary carbon atom, said tertiary amine nitrite salt being substantially stable at atmospheric temperature, soluble in water and in said organic material and normally non-reactive with said organic material.

Treatment of Pickle Liquor

U. S. Patent 2,433,458. *James M. Kahn, and Edward Kominek Jr., assignors to Infilco Inc.*

The cyclic process for the treatment



of waste pickle liquor containing free sulfuric acid, ferric sulfate and ferrous sulfate, which comprises mixing magnesium hydroxide with said liquor to neutralize free acid and precipitate all of the ferric iron as ferric hydroxide and a minor portion of the ferrous iron as ferrous hydroxide, separating the resulting precipitate from said solution, adding calcium hydroxide to said liquor to precipitate the balance of the iron as ferrous hydroxide, thereby forming a mixed solution of calcium sulfate and magnesium sulfate, the liquor being kept sufficiently dilute to prevent precipitation of calcium sulfate therefrom, separating said solution from said ferrous hydroxide, adding dolomitic lime to said solution to precipitate magnesium hydroxide, and utilizing a portion of said magnesium hydroxide for the treatment of additional quantities of waste liquor.

Corrosion Preventive Compositions

U. S. Patent 2,433,572. *Paul R. McCarthy and Elliot S. Francis, assignors to Gulf Research & Development Co.*

An improved corrosion preventive composition comprising, from about 5 to about 30 per cent by weight of an alkali salt of sulfonated degras, from about 10 to about 30 per cent by weight of an alkali salt of oil-soluble petroleum sulfonic acids, from about 5 to about 35 per cent by weight of unsaponifiable oxidized petroleum stock and a volatile solvent.

Electrode for Use in Electrolytic Cells

U. S. Patent 2,433,212. *Wilfred Wilson Gleave, assignor to Imperial Chemical Industries Ltd.*

An electrode adapted for use in a cell for the electrolysis of an aqueous salt solution, which electrode is formed of porous carbon impregnated with a polymer of a lower alkyl ester of an acid selected from the group consisting of acrylic acid, methacrylie and alpha-chloro-acrylic acid which has been polymerized in situ, said impregnation being to the extent that between about 35 and 45% of the pore space of the electrode is impregnated with the resinous polymer.

Oil-Bath Tin-Plate Flowing Apparatus and the Like

U. S. Patent 2,434,599. *Glenn E. Stoltz, assignor to Westinghouse Electric Corp.*

In combination, a liquid-bath means, work-feeding means adapted to rapidly move a flexible elongated member, in the direction of its length, through the liquid-bath means, said liquid-bath means having guide-means therein for so guiding said elongated member as to provide a substantially vertically extending, downwardly moving portion of said elongated member which moves downwardly through the top surface of the liquid-bath into the bath, and an upwardly moving portion of said elongated member which moves upwardly through the top surface of the liquid-bath out of the bath, means for heating the upper portion of the downwardly moving portion of the elongated member, liquid-circulation cooling-means for causing an intermediate portion

Vapor Degreasing

Vapor degreasing is one of the most thorough and therefore one of the most important methods available for the removal of greases, oils, and waxes from metallic surfaces.

The process is based on the fact that contact of the cool metal surfaces with the boiling vapors of the solvents causes the solvents to condense on the parts, where their strong affinity for oils causes these materials to be dissolved and flushed away by the condensate, as it drains from the metal.

The two solvents which are used almost exclusively in modern degreasing equipment are *trichlorethylene* and *perchlorethylene*. The properties of these two materials which are of practical importance are listed in the following table.

PROPERTY	TRICHLORETHYLENE	PERCHLORETHYLENE
FORMULA	$CHCl:CCl_2$	$CCl_2:CCl_2$
BOILING POINT	188.8° F.	249.8° F.
HEAT OF VAPORIZATION	103 BTU/lb.	90.2 BTU/lb.
FLAMMABILITY	Non-flammable at ordinary temps. and moderately flammable at higher temps. (Underwriters Classification # 3.)	Non-flammable at any temp. (Underwriters Classification 0.)
TOXICITY	All chlorinated hydrocarbons will produce nausea, dizziness, and headaches from prolonged exposure. Both trichlor and perchlor are allowable in concentrations up to 200 ppm in air without becoming harmful.	

While trichlor is the most widely used, perchlor has the advantage of the more stable formula, and is less apt to break down into a corrosive product.

Where very light gauge metal parts having considerable soil on them are to be cleaned, perchlor offers the best possibilities due to its higher boiling point which gives a longer condensing and draining time.

The lower boiling point of trichlor permits lower steam-heating pressures and less heat input to the new equipment.

Both solvent vapors are considerably heavier than air, but the increased density of perchlor vapors shows a definite superiority in keeping vapors confined to the machine and in preventing evaporation losses.

The higher boiling point of perchlor, which is well above that for water, causes the immediate volatilization of any moisture that may be introduced into the machine. This minimizes any possibility of hydrolysis of the solvent and the resulting pitting action on the metal.

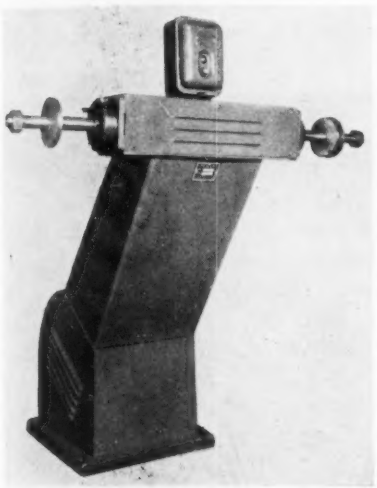
New Methods, Materials and Equipment for the Metal Finishing Industries

Recent Developments

Large-Overhang Buffing Machine

Pesco Plating Equipment Corp., 182 Grand St., Dept. MF, New York 13, N. Y.

Announcement is made by the above firm of a 3 H.P., two-spindle buffing and polishing lathe having the important feature of a large overhang of the spindle, making possible the handling of long and intricately shaped parts. This long overhang permits getting into the crevices of odd-shaped pieces, and gives the operator plenty of free foot space for good balance.



The shaft is made of high-carbon steel, accurately ground and polished for long, trouble-free service. Other models are available up to 10 H.P., and all incorporate the single-unit type shaft assembly mounted between precision Fafnir bearings, which makes replacement or servicing a very simple procedure. Furnished complete with overload reset starter, wrench, flanges and nuts, and grease gun.

Removable Plating Rack Tip

National Rack Co., Dept. MF, 22-06 Morlot Ave., Fair Lawn, N. J.

Announcement is made by the above firm of a novel type of rack tip that can be removed and replaced when worn out without disturbing the insulation on the main part of the rack. By using this type of changeable tip, the center stem of the rack may be used with various tips to accommodate many different types of parts, lending flexibility without excessive inventory of racks. Changing of tips is an easy and rapid procedure, according to the manufacturer.

High Votage Selenium Rectifier

Rapid Electric Co., Dept. MF, 2847 Middletown Rd., Bronx 51, N. Y.

The above firm announces the addition to their line of two new selenium rectifiers having a voltage range of 0-10 and 0-15 volts. These units incorporate extra large full-wave bridge selenium rectifier stacks, accurately calibrated voltmeter and ammeter continuous output control, and overload protection. The units come ready for plugging into the supply line for immediate operation. Both models operate on an input source of 115 volts A. C. Single Phase. Maximum rated output is 50 amperes. Other models by this firm include a range up to 500 amps, 6 volts.

Plastic Tape for Plating Racks

Minnesota Mining & Manufacturing Co., Dept. MF, St. Paul, Minn.

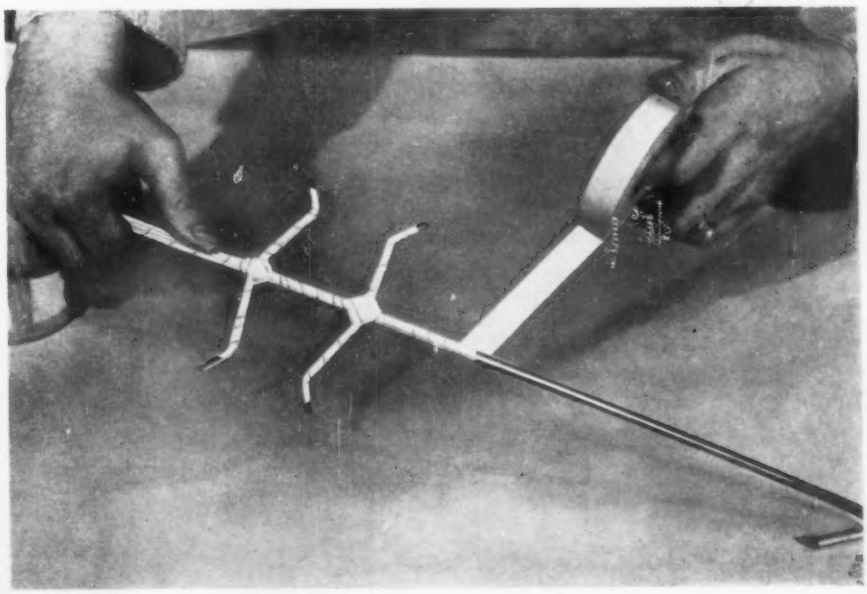
A new tape—designed as a wrap insulator for electroplating racks and for blocking off parts being plated—is now being distributed nationally by the above firm.

Trade-marked "Scotch" Plastic Film tape, the new product is offered in yellow, black and white films, all reported to have excellent resistance to acids, alkalies, water, salt water, alcohol, aliphatic hydrocarbons, and oils.

In addition, the yellow variety was specially formulated to give it the further chemical resistance necessary to meet the severe requirements of the electroplating trade, the 3M Company laboratories said.

The yellow tape will withstand prolonged immersion in most electroplating solutions, including hard chrome plating, without becoming brittle or cracking, according to the manufacturer and it will withstand most cleaners, either hot or cold, including acids and caustics. It is not designed to be resistant to potash or tri-chloro-ethylene cleaners and de-greasers.

Designed to have sufficient flexibility to mold tightly to irregular surfaces, the tape has an elongation at break of 175 per cent, with stretch in the transverse direction slightly higher. Tensile strength is 30 pounds and adhesion is



30 ounces, both per inch of width. Thickness is seven mils.

The tape is provided in 36-yard rolls, in widths from a quarter-inch to 22 inches.

Laboratory tests reveal an insulation resistance of 50,000 megohms, and a dielectric strength of 10,000 volts. It is incombustible, non toxic, and odorless.

Contact Wheel for Belt Polishing

Divine Bros. Co., Dept. MF, 200 Seward Ave., Utica, N. Y.

A new contact wheel for abrasive belt polishing has just been announced by above firm. This new contact wheel, called "Beltflex", has been designed to

eliminate the necessity of using buff sections under abrasive belts. The Beltflex wheel has all of the advantages of the buff sections, plus controlled balance and density . . . and a smoothly ground surface, which makes for uniform belt tracking.

The Beltflex contact wheel is available in two degrees of density—one, type "E", offering great flexibility; the other, type "G", flexibility with aggressive cutting action. Beltflex wheels are balanced to run smooth and true—give constantly accurate pressure to the working surface. Their flexibility allows for light contour work of high quality.

Face widths and diameters for most requirements are available. Recommended for use with J weight (jeans cloth) abrasive belts.

Rubberized Work Gloves

Edmont Mfg. Co., Dept. MF, Coshocton, O.

After nearly 6 years of being off the market, GRAB-IT all purpose work

gloves are again available, according to the makers.

These fabric-lined gloves with a natural rubber, rough finish are said to have new improvements, such as, more styling, greater comfort and higher wear-resistance.

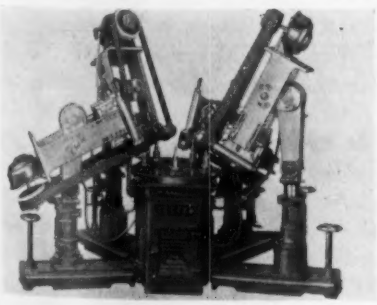
The present GRAB-IT work gloves are available in two styles as illustrated —No. 660, rubber coated all over; or No. 60, with fabric ventilated back.

For oily or greasy jobs, this style may also be had in smooth finish Neoprene coating all over (style No. 909), or with ventilated back and Neoprene coated palm (style No. 93).

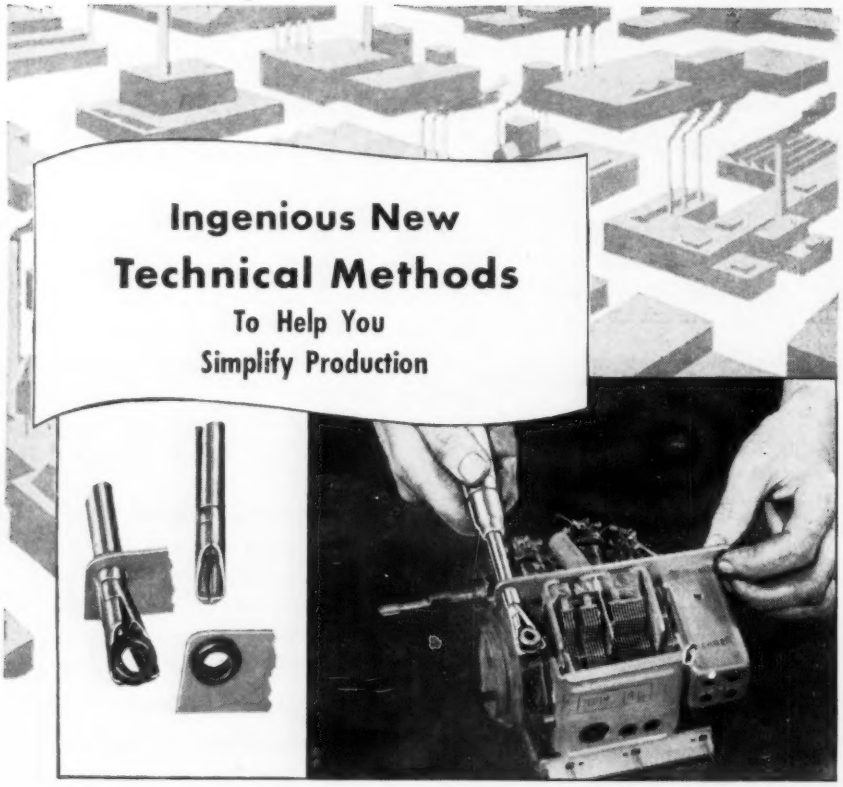
New Abrasive Belt Head for Packer-Matics

Packer Machine Co., Dept. MF, Meriden, Conn.

A special abrasive belt head for automatic polishing and buffing is announced by the above company. The new interchangeable head permits various types of wheel applications as well as the use of abrasive belts.



Standardization of mounting design makes it adaptable to most types of Packer-Matics now in use. The ability

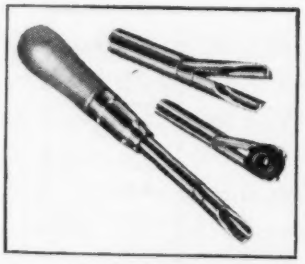


New Tool Inserts Rubber Grommets Quickly . . . Easily!

A new tool called a Grommet Inserter is shown above inserting a rubber grommet in a Sub-Chassis of a Zenith 7H820 Table Model Radio. The inset illustrates a close up view of the Grommet Inserter before and after the grommet has been inserted.

Anyone can insert grommets in an instant with the new Grommet Inserter. Saves time, labor, and assures perfect fit. No longer is it necessary to use the time-consuming, cumbersome method of insertion by hand. The new Grommet Inserter does it efficiently.

Simple as A-B-C. All you do is push the Grommet Inserter through the hole, open jaws, place grommet in jaws, and pull back—leaving grommet firmly in place, and perfectly fitted. Comes in four standard sizes: 1/4", 5/16", 3/8", 7/16". Can be furnished in any special sizes to order.



Grommet Inserter

You can count on chewing gum, too, to help step up employee's on-the-job efficiency. Chewing gum helps relieve tension and thereby enables him to work quicker and easier while leaving hands free. That's why more and more plant owners are making Wrigley's Spearmint Gum available to everyone.

Complete details may be obtained from
D. B. Rich Manufacturing Co.,
6217 Melvina Avenue Chicago 30, Illinois

AC-61

of these machines to handle changes in product design without necessitating any change in equipment is thus greatly increased.

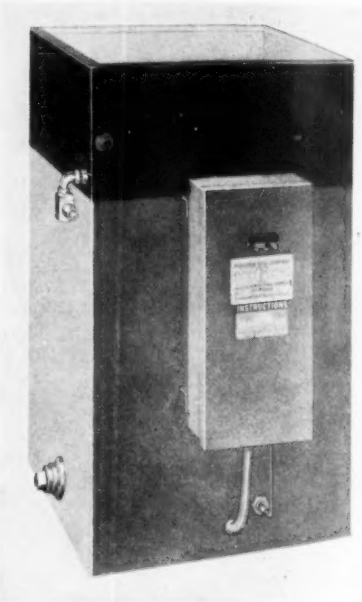
The flexibility of the new abrasive belt head permits single operating automatic buffing and polishing of such items as door knobs, cooking utensils and die-castings.

The new head will accommodate the use of buffs, polishing, tampico, and wire wheels or an abrasive belt, according to the manufacturer.

Electrically Heated Vapor Degreaser

Phillips Manufacturing Co., 3475 Touhy Avenue, Chicago 45, Ill., Dept. MF.

As an addition to their regular line



of engineered production degreasers, this company announces a new electric vapor degreaser specifically designed for the economical cleaning of small parts.

Outstanding for its low initial cost and operating cost, the Model 24 is small in size, light in weight and completely movable to any corner or the plant where suitable electric power and water connections are available, it is claimed.

High operating efficiencies are claimed through the use of the patented Phillips Reso-Kleen Sump which permits reclamation of soiled solvent within the degreaser without the necessity of costly shut-down. It is estimated that this compact production degreaser will clean steel at an average rate of 400 pounds per hour. Built for appearance

as well as service, the sturdy all welded tank has its exterior finished in attractive machinery blue and the entire interior protected by corrosion resistant zinc metal spray.

Heavy-Duty Selenium Rectifier Cells

International Rectifier Corp., Dept. MF, 6809 S. Victoria Ave., Los Angeles 43, Calif.

Announced by the above firm is a new Selenium Cell designed for heavy duty operation.

These Type "H" selenium cells have the following features:—

1. *Mechanical Dimensions.* 6¼" x 7¼" with ⅜-16 mounting stud.
2. *Reverse Voltage.* Reverse voltage of 20 volts rms maximum.
3. *Current Carrying Capacity.*

	amps.
Half wave single phase	6
Center tap single phase	12
Bridge Single phase	12
Half wave three phase	15

Center tap three phase	20
Bridge three phase	17

4. *Forward Drop.* Approximately 1 volt at rated current.
5. *Aging.* Change in voltage output is less than 5% after 10,000 hours of operation.
6. *Efficiency.* The efficiency of selenium rectifiers varies with the type of circuit used. Three phase bridge and center tap circuits have efficiency of the order of 82% and single phase bridge and center tap circuits have efficiency of the order of 70%.
7. *Long Life.* Selenium rectifiers have exceptionally long life and usually outlive other circuit components. Selenium rectifier installations have been found to operate satisfactorily over periods exceeding 40,000 hours.
8. *Rigid and Conservative Design.* Type "H" assemblies have an interlocking arrangement which prevents

the cells and terminals from moving on the central stud. This feature assures uniform position of terminals and proper line up of cells in final assembly.

9. *Moisture-Proofing.* Type "H" assemblies are supplied with multiple coats of synthetic varnish which are especially adaptable for efficient moisture-proofing. The color of the varnish is black in order to improve the cooling by radiation.

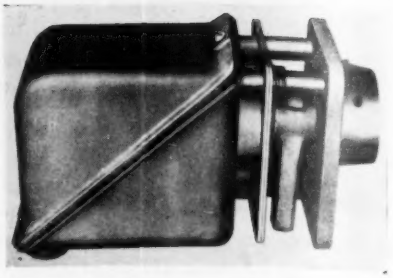
International Rectifier Corporation is an engineering organization and rigid quality specifications are set for each operation. The Engineering Department of Int. R.C. offers its fullest cooperation in helping to solve any problems which may arise in applications of selenium rectifiers.

Photoelectric Combustion Safeguard

Combustion Control Corp., Dept. MF, 77 Broadway, Cambridge 42, Mass.

This corporation introduces to the combustion field a photoelectric scanner type for flame failure protection on oil burners. The equipment guarantees instantaneous burner shutdown in case of flame failure, thus providing a positive and immediate safeguard against this important and ever-present explosion hazard.

The scanner, Type 45PH5, consists of phototube and vacuum tube amplifier housed in a compact, dust-tight aluminum case. It is mounted on the burner so that it has a clear view of the oil flame. Fireye continuously monitors the oil flame and, when flame fails, instantly signals the auxiliary control equipment which cuts off the fuel supply or sounds an alarm.



Features of the equipment include an optical system incorporating a special heat-absorbing filter, and a hinged shutter permitting lens cleaning without burner shutdown. The scanner is small but rugged, resulting in flexibility of location on any burner. Other unique design features of the equipment result in ease of installation, adaptability to all oil burner heads, immunity to moisture and electrical leakage, and protection from combustion by-products.

Filtering Suppliers and Equipment

The Filter Paper Co., Dept. MF, 2426 S. Michigan Ave., Chicago, Ill.

Announcement is made by the above firm of their line of Filpaco Products, which includes activated carbon, filter-aids, glass filter cloth, filter papers and pads of various types, as well as the equipment required for industrial filtering operations.

The line also includes lined, corrosion-resistant tanks, portable agitators, rubber hose, and acid-proof buckets, pails, and baskets. The repairing and reconditioning of chemical processing and handling equipment is also an important part of the service rendered by this firm.

Magnesium Rod for Water Tank Corrosion Prevention

Dow Chemical Co., Dept. MF, Midland, Mich.

Cathodic protection with magnesium is not a new thing, but The Dow Chemical Company, of Midland, Michigan, announced for the first time its slender magnesium rod for use as an anode to protect water heating and storage tanks from corrosion.

According to the manufacturer, a magnesium anode made from a spe-

cial alloy developed for the purpose can be installed to prevent or greatly lessen corrosion caused by the battery reaction set up between water and the metal surface of hot water tanks. Magnesium's high driving voltage reverses the current flow and permits the anode to be corroded rather than the tank wall, thereby preventing pitting, leaks and eventual tank failure.

In many cases the storage tank is in better condition after the anode has entirely disintegrated than when the tank was new because of the protective film deposited on the tank wall. This calcareous coating even protects spots on tank walls where zinc has failed to adhere, protecting the underlying steel, it is claimed.

The anodes are manufactured from small-diameter magnesium rod containing a centrally located core of steel wire to prevent breaking up of the anode at points where concentrated attack takes place, such as places where the anode either contacts or closely approaches cathodic metal.

Rust-Proof Hose Ball-Valve

Paul Valve Corp., Dept. MF, 683 Third Ave., N. Y. C.

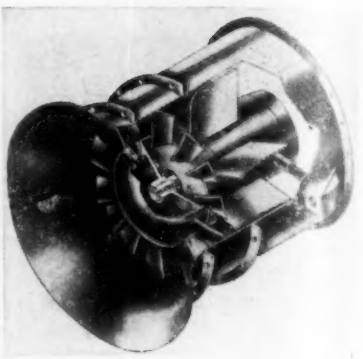
A new palm-size, hose valve of radically new design has been developed for use in a variety of industries from chemical plants, to breweries and food and drug product manufacture. By the use of an old hydraulic principle, it operates without springs and with only two moving parts — the operating plunger and the controlling ball, according to the manufacturer.

The hoze nozzle is discharged by pushing a button. This causes the plunger to roll the ball off its seat, giving instant full flow. At 50 p.s.i. hose pressure, less than 10-pounds finger pressure on the button opens the valve. Only 4 pounds of finger pressure are necessary to hold it open, giving approximately 13 gallons per minute through the nozzle.

When the push button is released, the difference in pressure between the center and the outside of the stream forces the ball into the valve throat, closing the valve and raising the push button plunger. The ball is held firmly against the seat by line pressure, making the line-contact seal.

The valve is available for standard hose sizes from ¼ inch to 1 inch, delivering up to 13 gallons per minute at 75 pounds per square inch line pressure. It is made entirely of Monel, including the ball and the plunger, for maximum resistance to corrosion and wear. The body is rubber-coated so that there is no danger of scratching interior surfaces of tanks or other equipment being cleaned. In addition, one model is fitted with a threaded replaceable nozzle that adapts the valve for use with long extension nozzles.

Because of their strong, rustproof construction, these hose valves may be used in all types of industrial plants, it is claimed. Paper Mills, breweries, dairies and packing plants in which these valves are used have found that their positive sealing action, automatic operation, and absence of leakage cut the consumption of wash water as much as half, according to the above firm.



The Series 1000 consists of axial-flow fans of the vaneaxial type designed for a range of pressures up to 9.60 water gauge and volumes up to 100,000 C. F. M. Joy fans are available in 124 different models—from various combinations of 15 different housing diameters (188" to 60"), 4 hub sizes, 16 motor-frame sizes, and 4 different speeds.

Adjustable-blades, a Joy development, insure great flexibility in performance. A simple, compact design with direct, in-line drive is said to lower installation costs, minimize space requirements and develop maximum volume and pressure per pound of fan-and-motor.

Rust Preventative

Consolidated Sales Agency, Dept. MF, 2509 Commerce St., Dallas, Tex.

Rust, the perennial foe of ferrous metals, seems likely to become only a minor irritant soon, if advance claims for the new solution, Consa-Rusto prove correct. The new solvent has demonstrated amazing ability to banish corrosion and scale from all metals, according to the manufacturer. It is not recommended for use with zinc and aluminum as it will mildly attack those two metals.

Consa-Rusto is compounded from a complicated formula of inhibited acids combined with a wetting agent, but is claimed to be completely harmless to humans as no hydrochloric, nitric or sulphuric acids are included. Likewise it will not attack bare ferrous metals since it only dissolves the rust oxides, according to the above firm. This material has demonstrated its effectiveness in cleaning pipe lines which have been buried near the sea; in removing rust from oil tanks and refining equipment; and in cleaning castings before they are coated. Used in city water

Corrosion Tester Measures Polarization

Glen A. Marsh, Dept. MF, 6059 Waveland Ave., Chicago 34, Ill.

A new instrument, the "Pulse Polarizer", has been developed for laboratories engaged in corrosion work. The instrument yields quantitative information on the extent to which metals polarize in given media, and may be used as a rapid means for obtaining the corrosion rate of metal. The Pulse Polarizer consists of a high voltage pulse circuit, sensitive electronic potentiometer, and high-speed recorder, and operates by subjecting a metal specimen to a brief but violent discharge and recording the polarization during and after this discharge. The data are reproducible, permanent, and distinctive for each set of corrosive conditions, it is claimed. Typical uses are in evaluating inhibitors, choosing proper corrosion-resistant alloys, determining corrosiveness of chemicals, and in controlling inhibitor concentration.

Adjustable Blade Fan

The Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Penna., Dept. MF.

The above firm announces its new and complete line of "Axivane" adjustable-blade fans, Series 1000, for all heating, ventilating, and air conditioning requirements in the industrial and commercial markets.

systems, it has been found valuable in cleaning brass and bronze water meters. Users mix the solution with water according to prescribed proportions to obtain the mixture suited to particular job requirements.

In-Line Filter with Porous Stainless Steel Filter-Elements

The Micro Metallic Corporation of 193 Bradford Street, Brooklyn 7, N. Y., Dept. MF.

The above firm announces production of "in-line" filters fitted with porous stainless steel filter elements.

These filters are provided with interchangeable porous stainless steel elements of various types. Removal of a filter element and replacement with another of different porosity or type can be accomplished within a matter of seconds, it is said. Fluid passageways are all readily accessible for cleaning. All connections are standard pipe threads. Quick disassembly and assembly is accomplished by use of rapid acting forged steel swing clamps for closure.

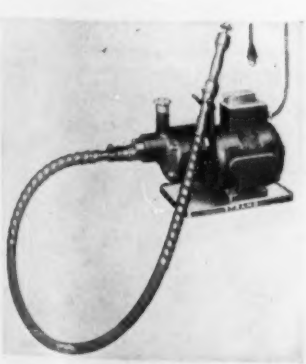
Units are available with filter areas ranging from 18 square inches to 24 square feet in pipe sizes from ¼" to 1½". Pore openings of the porous stainless filter elements range from 20 to 65 microns.

Flexible Shaft Grinder and Sander

N. A. Strand & Co., Dept. MF, 5001 *Wolcott Ave., Chicago* 40, *Ill.*

Announcement has been made by the above firm of a line of flexible shaft machines for grinding, sanding, buffing, and polishing. The photo above illustrates a bench-type machine. Other models are available with moveable floor stands and for overhead mounting.

These machines are all of the 4-speed gear drive type, utilizing a new type of quick-change gear. The units include totally enclosed ball bearing motors and grit-proof enclosed gear housing and switches. Sandard speeds are from 850-4500 rpm., but higher speeds up to 9000 rpm may be obtained. Also available in three motor sizes: ¼, ½, and ⅓ H.P.



Magnetic Separator

Multifinish Mfg. Co., 2116 *Monroe Ave., Dept. No.* 164, *Detroit* 7, *Mich.*

A load-releasing, light-weight, adjustable hand magnet of the permanent (non-electric) type has been introduced for rapid handling of steel parts by the above firm.

Completely self-powered and requiring no current, wires or batteries, the unit is operated with one hand and lifts up to 15 pounds. It instantly releases its load when a finger-tip lever is raised. Within the moisture-proof aluminum and stainless steel case are two 4-inch Alnico magnets which, it is stated, will not lose power, regardless of kind or length of use. It requires no servicing and has nothing to get out of order. Dimensions are 3" x 5½" x 8"; weight 3¾ pounds.

Known as the Multilift Model S Magnetic Separator, the magnet has been saving both labor and material, according to the manufacturers, in drawing steel parts from tumbling media; handling nuts, bolts, screws, nails and small parts.

Detecting Combustible Gases or Vapors

Davis Emergency Equip. Co., 45 Halleck St., Newark, N. J. Dept. MF.

For the determination of hazardous conditions due to the presence of combustible or explosive concentrations of flammable gases or vapors, the above concern, manufacturers of gas detection and alarm equipment, announce their new supersensitive Vapotester.

The basic principle of the Vapotester indicator is the measurement of increases in the resistance of a filament when exposed to a gas or vapor-air mixture as compared with a filament not exposed to such gas or vapor-air mixture.

The new Vapotester goes a step beyond the analysis of a combustible gas in terms of its lower explosive limit, as it permits the operator to indicate gases in their toxic range, according to the manufacturer.

A calibration curve chart, is furnished with the instrument and shows how the Vapotester will read on certain gases.

Movie on Abrasive Belt Polishing Available for Instruction

Porter-Cable Machine Co., Dept. MF, 1714 N. Salina St., Syracuse 3, N. Y.

A novel departure in industrial movies distinguishes the new film, "A Machine of the Age," from previously released abrasive belt machining films. Many of the sequences of the new film, showing the abrasive belt machining method in action, were filmed during working hours and under actual working conditions in different shops throughout the country.

The movie traces the development of abrasive belt machining from the earliest dry-belt models to its present status utilizing special cloth-backed abrasive belts for use with coolants or soluble oils.

Among operations featured are: removing risers, flashings and parting lines from castings; surfacing large flat areas to close tolerances, chamfering, edging, squaring, rounding and cutting radii on single piece operations.

The automatic feed table, which substitutes mechanical pressure for hand pressure, and permits machining to closer tolerances, is also presented.

The film is black and white. 16mm. Sound. Running time is 30 minutes. Obtainable free of charge, except return postage, by writing to the above firm.

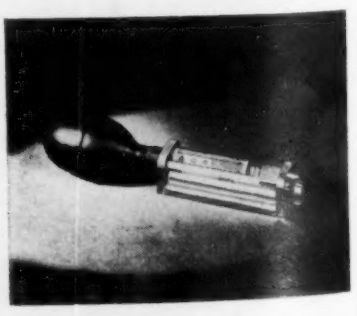
Portable Carbon Monoxide Tester

Mine Safety Appliances Co., Dept. MF, Pittsburgh, Pa.

Among the new safety products recently announced by this company is the M. S. A. Carbon Monoxide Tester.

This instrument is designed to determine the presence of deadly carbon monoxide concentrations in air, and employs the most advanced colorimetric method of CO detection.

Simple in operation, and requiring no special training to use, the carbon



monoxide tester is capable of indicating the presence of carbon monoxide from 0.001 to 0.10 per cent by volume in air, it is claimed.

If the air sample contains carbon monoxide when it is drawn through the tube, the yellow indicating chemical turns varying shades of green, directly proportional to the CO concentration; the degree of discoloration of the gel is then compared with the instrument's integral revolving color scale for quick and easy reading.

The M. S. A. Carbon Monoxide Tester is adapted to surveys of industrial atmospheres, mine ventilation currents, garages, bus terminals, the interior of aircraft, passenger cars, buses, blast furnace and open hearth operations, public utility mains and conduits, artificial gas plants, and wherever the accurate determination of low concentrations of carbon monoxide is desired.

Tampico Wheels and Platers Brushes

Dixon & Rippel, Dept. MF, 479 Hasbrouck Ave., Kingston, N. Y.

Announcement is made by this firm of a line of tampico wheels, wire wheels, and hand brushes as used for scrubbing operations in the plating room. The wire wheels are available in Brass, Nickel Silver, Steel, or special wires, from 2½-8 inches in diameter. Their tampico brushes are made in sizes up to 12 inches in diameter. Also included are brushes having NYLON bristles.

The platers hand brushes are available in several handle styles, and with various types of bristles. A cotton Potash brush is also included in this group. All these brushes are constructed to give long and satisfactory service in the polishing and plating departments.

Business Items

Udylite Honors 20-Year Employees

Two employees of the *Udylite Corp.*, of Detroit, leading manufacturers of plating equipment, were honored last week, at a special banquet in the Hotel Biltmore, New York, as they joined the company's exclusive Twenty Year Service Club.

L. K. Lindahl, Udylite president, pre-

sented wrist watches set with 20 diamonds to *Rosemary Duff* of New York, the company's oldest girl employe, and *Helen McKay* of Detroit, his private secretary, who went to New York for the occasion. In addition, both received the usual 20-year gold pin.

The entire staff of Udylite's New York office attended the affair which included cocktails followed by dinner in the main dining room of the Biltmore.

Tin Conservation Program Now in Effect

The tin conservation program of the Department of Commerce went into full effect February 29, as scheduled. *H. B. McCoy*, Director of the Department's Office of Materials Distribution stated recently. This is the effective date originally set, but actual inauguration of the program was dependent on extension by Congress of the Second Decontrol Act of 1947. Congress extended this legislation for a period of three months from Feburary 29.

Tin savings of approximately 2,750 tons during 1948 are expected to result from the measures of Direction 10 to Conservation Order M-81, if the Congress decides later to extend the requisite legislation through the remainder of the year, or longer. In part, these restrict individual manufacturers' use of tin in the form of tinplate, limiting their 1948 usage to the amounts of their 1947 receipts. Similar limitations are placed on the amounts of tin that may be used in making cans for certain specified products. In addition, plate specifications are provided for cans for some products.

When he announced the restrictions last month, *Secretary Harriman* said that the Department of Commerce had decided against proposals to reduce the tin coating on cans for certain food products, as well as against reinstitution of can size specifications. Mr. Harriman also emphasized at that time that the conservation measures decided on had been worked out after a long series of conferences with industry representatives.

Moore Appointed Manager of Sales for Optimus

Mr. Van Winkle Todd, president of *Optimus Detergents Company, Matawan, N. J.*, has announced the appoint-

ment of *Mr. Clark Moore* as Manager of Sales.

Mr. Moore brings to Optimus a wealth of experience in the sale of industrial products. Prior to joining Optimus, he was sales manager of the asphalt paving and industrial sales divisions of the *Barber Asphalt Corp.* During the war period, Mr. Moore

Clark Moore

was with the New York Office of the War Production Board as Chief Engineer. He later went with the Smaller War Plants Corporation as assistant Regional Deputy Director. Previous to his work with the government, he had been President and General Manager of the *Equitable Asphalt Maintenance Corp., of Kansas City, Mo.,* manufacturers of highway equipment.

Du Pont Promotes Holladay

L. P. Holladay, III has been appointed manager of sales development in the Chlorine Products Division of the Du Pont Company's Electrochemicals Department.

Mr. Holladay will be concerned with sales of perchloroethylene, trichloroethylene, methyl chloride, methylene chloride and chloroform.

He received his degrees of chemical engineer and bachelor of science from the M.I.T. and joined Du Pont in 1934. After a year in Philadelphia, he was transferred to the Industrial Engineering Division and stationed at Grasselli, N. J., and later at Niagara Falls.

In 1941, he became a development engineer in the Electrochemicals Department and in 1944, a technical development investigator, from which position he was promoted to his present post.

Pennsalt Names Salesman for St. Louis

The Pennsylvania Salt Manufacturing Co., today announced appointment of *Charles R. Sorber, Jr.*, of Philadelphia, as St. Louis, Mo., district sales representative for Pennsalt's Special Chemicals Division.

Mr. Sorber, a graduate mechanical engineer from Pennsylvania State College, has served three years in the Navy in the Pacific. Prior to joining Pennsalt last September he was a sales engineer with *Proctor & Schwartz, Inc.*

Mr. Sorber's territory will include all of Missouri and the southern section of Illinois.

Calgon Appoints Ralston as Research Chemist

Because of industry's growing use of *Banox*, new rust-proofing chemical, an additional research chemist is being assigned to full-time work on this product, it is announced by *Calgon, Inc., Pittsburgh, Pa.*

Paul H. Ralston, who holds a master's degree in chemistry from Carnegie Institute of Technology, will devote his full time to research aimed at improving the product and its performance.

Paul H. Ralston

Mr. Ralston received the Bachelor of Science degree at Thiel College, Greenville, Pa., in 1939, and his M. S. in chemistry at Carnegie Tech in 1942. He was employed in the metallurgical laboratories of the Jones & Laughlin Steel Corporation's Aliquippa Works in 1939 and 1940, and joined the research staff of Calgon, Inc., Pittsburgh, in 1941.

New Plating Rack Company

Mr. E. L. Faulman, formerly vice-president of the Standard Plating Rack Co., has announced the formation of the *National Rack Co.*, with headquarters at 20-06 *Morlot Ave., Fair Lawn, N. J.* The company is equipped to manufacture all types of plating racks, and will feature rapid delivery of new and repaired racks to its customers in the East. New racks made by this firm will feature a removable-type of tip developed by them, Mr. Faulman stated, and all racks will be covered with an insulating material guaranteed for a year with normal use. Mr. Faulman has also been a Process Engineer for General Motors and Chrysler Corp.

E. L. Faulman

Udylite Holds Sales Conference

L. V. Nagle, Sales Manager, in his address to over 70 sales-service men of the *Udylite Corp.* at the company's annual sales conference held at the Detroit Hotel Statler March 8-10, predicted a further increase in the sales volume for the coming year, and cited a 30% increase over the previous year's business as a significant trend, principally in the field of bright plating. A new type of plating equipment was announced and demonstrated, and the sales personnel were also given a series of demonstrations in the company's present line of equipment. The company's advertising plans for the coming year were also explained.

At the banquet that followed, a gold watch was presented to *Mr. A. B. Hoefer*, New York District Manager,

in recognition of his 20 years service with the firm. The presentation was made by *Mr. L. K. Lindahl*, President of Udylite.

Aristol Co. Opens New Plant

The new plant of the *Aristol Company*, located in Fairfield, Conn., was occupied on March 15th. The firm specializes in the plating of aluminum alloys, including Gold and Chrome on aluminum, as well as anodizing. The new building is modern in design and will add greatly to the facilities already established.

Wilson to Head Brown Sales in East, Northeast

O. B. Wilson has been named industrial manager for the eastern sales region of the *Brown Instrument Division* of *Minneapolis-Honeywell Regulator Co.*, it was announced by *L. M. Morley*, vice president of the Honeywell organization and its Brown division.

O. B. Wilson

Wilson's promotion will make him regional manager of the territory extending from northern Virginia, through eastern Pennsylvania, to the Canadian border, west to Rochester, N. Y., and in New England.

Wilson has been with the Honeywell-Brown organization for the past 25 years. He has served as a sales engineer in various parts of the country and has been industrial manager in Houston, Chicago and New York. He will continue to make his headquarters in New York City where he has been the Brown manager for the past two years.

Pilot Chemical Co. Plans Expansion

The Pilot Chemical Co., Darlin St., East Hartford, Conn., manufacturers of plating racks, have completed plans for a new building to house the expanding activities of the business. The new quarters are expected to be ready for occupancy in early summer.

The company was founded by *Mr. Savin Zavarella*, who was formerly a plating supervisor for Pratt & Whitney Aircraft, and also a Finishing Service Engineer for the Pennsylvania Salt Mfg. Co. The firm also makes metal cleaners and acts as distributors for other finishing supplies.

Associated with Mr. Zavarella is *Mr. Francis E. Lally*, formerly Chief Chemist of the Chromium Process Corp. Mr. Lally will handle the sales engineering work.

Metal-Clean Appoints Representatives

The Metal-Clean Solvent Corp., 1935 *N. Paulina St., Chicago, Ill.*, announces the recent appointment of *Thomas Burke*, 18216 Landseer Rd., Cleveland, Ohio; *Clemco Chemical Co.*, 3614½ Division, South, Grand Rapids, Mich; *Carlson Equipment and Supply Co.*, 1951 East Ferry Avenue, Detroit; *L. J. Kissling & Sons*, 41 Union Square, New York City, and *J. H. Lightner*, 428 E. King St., Lancaster, Pa., as exclusive representatives.

The Metal-Clean Solvent Corporation states that these men have completed courses of study in the application of Metal-Clean Solvents to the washing of metal in production, and that this training supplements the wide experience which these men have had in the metal cleaning field, and better enables them to advise industry on the latest and best methods of soil removal

Bowditch Joins Lead Industries

Manfred Bowditch, formerly Field Director of the *Saranac Laboratory* and Director of the Division of Occupational Hygiene of the *Department of Labor and Industries of the Commonwealth of Massachusetts*, has been appointed Director of Health and Safety of the *Lead Industries Association*. He will make his office at the Association's headquarters, 420 Lexington Avenue, New York City.

Mr. Bowditch has had a long and

Manfred Bowditch

distinguished career in health and safety work. It is believed that Mr. Bowditch was the first full-time hygienist employed by any U. S. industry, when he was affiliated with *General Electric Company* in 1925.

In addition, Mr. Bowditch has been lecturer and instructor on industrial hygiene at the *Harvard School of Public Health* and has been Professor of Industrial Hygiene at the *Tufts College Medical School*. He is author of numerous articles on industrial health and safety subjects and has lectured at many meetings of leading organizations in these fields.

Mr. Bowditch's appointment should enable the Lead Industries Association to increase its usefulness to industry, and to the public generally through full-time investigation and education in the important field of health and safety.

NEW BOOKS

Hot Dip Galvanizing Practice

By *William H. Spowers, Jr.* Second Edition. Published by *The Penton Publishing Co., Cleveland, Ohio.* Price $6.00.

This second edition of Mr. Spowers book contains most of the material which was presented in the first edition, with numerous additions. This volume is a practical treatise on hot-dip galvanizing methods and should be in the library of any one engaged in this phase of finishing operations. Theoretical discussions are kept at a

minimum with emphasis on actual shop techniques and equipment, with a generous helping of photographs and illustrations of shop operations.

A serious error in this book, at least to this reader's mind, is the very short chapters IV, V, VI, and VII. All of these are on Pyrometry and together cover less than eleven pages. A more satisfactory arrangement would have been to combine these into one chapter.

In spite of this, however, this book fills a definite need for information understandable and usable by the shop man. An unusually large bibliography is included for those who might want to pursue the subject further.

W. A. R.

The Plating of Zinc Alloy Die Castings

Zinc Alloy Die Casters Ass'n, Lincoln House, Turl St., Oxford, England. Price $1.50.

This volume covers the field of electroplating and polishing the zinc alloys in die-cast form, with particular emphasis on the various plating baths and their control. Some very timely information on designing die castings to alleviate finishing problems are also included. Proper attention to these fundamentals would go a long way towards lower over-all finishing costs, which is usually the forgotten step and not seriously considered in the design stage of manufacturing.

For the most part, the book is a compilation of the important new developments in the field, and the work of many authorities is cited. One of the very useful parts is a chart of the characteristics of the bright nickel baths, which gives the most complete tabulation of the composition and properties of these baths that has ever come to this reader's attention. Another valuable chapter is the one on maintenance and purification of plating baths, and the effects of specific amounts of various impurities on nickel solutions.

This book will make an excellent reference source of information for anyone who is engaged in finishing zinc die castings.

W. A. R.

Letter to the Editor

Editor

Dear Sir:

In reading your column "Business Items", I noted with interest your reference to our former employe *Edwin C. Rinker*. In view of the fact that you inadvertently omitted reference to his most recent activities, I thought you would like to supplement the information which you have given to the trade.

Mr. Rinker was in our employ from January 1946 to December 1947. During his employment with our firm, he was entrusted with all of our confidential information, and he acted in various capacities including research chemist, salesman and consultant.

As you probably appreciate, the most recent employment is always of greatest informative value. In view of his position of trust with us and with the Manhattan Project, he enjoyed our complete confidence in all matters pertaining to our business. It is our opinion that you undoubtedly will wish to give this supplemental information as

much publicity as you did the original item.

We wish him success in his new occupation.

Very truly yours,
Ben. Robinson
A. Robinson & Son

Manufacturers' Literature

Free, valuable information on equipment and processes. Write to the manufacturer and department listed for your copy.

Buffing and Coloring Compounds

Buckeye Products Co., Speedie Division, Dept. MF, Cincinnati 16, *O.*

Fabricators and manufacturers in the metal-working industry, interested in improving buffing and polishing operations, will find the new, 2-color, 20 page book just published by above company, filled with valuable reference data on polishing, buffing and coloring compositions and their use.

The book contains a full-page chart showing the correct polishing, buffing and coloring composition for each particular metal surface. Complete descriptions of the working qualities and practical applications of various types of compositions, including Tripoli Nickel, Stainless Steel and Chrome, Greaseless Compositions, Emery Cake and Grease Stick and the popular "Spray-It" Liquid Compositions, are presented.

Convenient too, is a section on many types of quality buffs and polishing wheels. Each is illustrated and described and its application to a specific operation in the buffing room is given. A helpful table for computing the peripheral speed of a wheel, is also among the practical data included. Write for Bulletin 48-1.

New Bulletin on 71-Point Lead Anodes

Division Lead Co., Dept. 115, 836 *W. Kinzie St., Chicago* 22, *Ill.*

A significant increase in chrome plating efficiency is achieved thru the use of Divco 71-Point lead anodes, as described in the new Divco technical Bulletin 8A, issued by this company, who are also manufacturers of lead, solder and lead alloy products.

Copy mailed promptly on request to the manufacturer.

Drying and Sawdust Barrels

Belke Mfg. Co., 947 *N. Cicero Ave., Dept. MF, Chicago* 51, *Ill.*

Gives complete information on Belke steam-heated sawdust drying barrels and sawdust separators for fast and efficient drying of small parts before and after electro plating.

Belke steam-heated sawdust barrels dry the work, leaving it bright, clean and free from water spots, according to the manufacturers. The sawdust separators separate the work from the sawdust, quickly, and with minimum labor. Also fully dscribed is a new combination unit, a sawdust barrel with the separator attached that affords even greater efficiency and labor saving.

Copy of the bulletin mailed promptly on request to the above address.

Buff Cloth Samples

Divine Bros. Co., Dept. MF, 200 Seward Ave., Utica, N. Y.

A catalog page, showing ten samples of cloth used for making buffs has just been issued by this company.

These sheets have the actual material glued on the page in such a manner that it can be readily examined. Beside each swatch is a brief description of the recommended use for that quality.

Readers are invited to write for this sheet, asking for "Buff Cloth Bulletin —FDB-3".

Booklet on Adhesives & Coatings

Minnesota Mining & Mfg. Co., Dept. MF, 901 Fauquier Ave., St. Paul 6, Minn.

Research help for industrial customers, in choosing the right adhesives, sealers and coatings, is offered in a new brochure by this firm.

Entitled, "3M Adhesives in Industry," the 28-page brochure contains 40 pictures, cites 18 case histories, and lists 26 of the more than 1,000 formulae offered by the company's adhesives and coatings division in Detroit.

Pictured are bonding operations such as plywood-to-metal and vinyl-sheeting-to-wood; sealing operations involving aircraft cabins, auto bodies, and boat decks; and protective and anti-corrosion coatings for metal.

Included in the case histories are such industries as automotive, aviation, ship building, oil and refrigeration. Copies are available on request to the firm's offices at 901 Fauquier Avenue, St. Paul 6.

Associations and Societies

AMERICAN ELECTROPLATERS' SOCIETY

1948 Convention News

The elaborate plans for a huge and most successful convention by the *American Electroplaters' Society*, sponsored by the Newark Branch, are now nearing a final stage. The dates for the 1948 Convention will be June 28 through July 1. The headquarters will be the Ambassador Hotel at Atlantic City, N. J.

This important event sponsored yearly by the electroplating industry is expected to draw a crowd of about 1,500 to 2,000.

The most important features of this event are as follows:

1. The technical sessions under the chairmanship of *Mr. M. Diggin*, consisting of about 16 highly educational and very pertinent technical papers.

2. The Industrial Finishing Exposition which is scheduled to be held in the huge auditorium in the Atlantic City Convention Hall. Here, one will find large displays of equipment and supplies for electroplating, polishing and buffing, cleaning and degreasing, washing and rinsing, and lacquering and enameling. Many pieces of automatic equipment, as well as all other types of equipment of recent design, may be viewed at this exhibit, some of them in actual operation.

3. An exhibit of plated ware of unusual design, featuring commercial and special finishes, will be held at the Ambassador Hotel. Here the platers of the nation, and perhaps even foreign countries, will exhibit their skill. This

particular feature will undoubtedly be very interesting and educational.

4. The social activities, which will consist of an excellent program for the entertainment of the ladies while the men are occupied with the business and educational activities of the convention. The fellowship party, presided over by our old friend, *Mr. Tom Trumbour*, has always been one of the highlights of the social events. The Aunt Ella party is an affair that needs no introduction. *Mr. Dave Clarin*, who is the sponsor and the host, blends his genial personality and ready wit to make this affair something to be remembered by our lady guests for a long time to come.

As a climax to all preceeding activities, the concluding social event will be the main banquet.

Rochester Branch

The regular Monthly Meeting of the Rochester Branch of the A.E.S. was held on Friday, February 20, 1948 at the Hotel Seneca.

Four applications for membership were voted to take the usual course. The Rochester Branch now has over 100 members.

The Spring Regional Meeting of the Rochester, Buffalo, and Syracuse Branches will be held at the Hotel Seneca on April 24th. Among the speakers will be *Mr. Kenneth Huston*, President of the A.E.S., who will speak on "Electropolishing of Stainless Steels" and "Affairs of the National Society." *Dr. D. Gardner Foulke* of Hanson-Van Winkle-Munning Co., will speak on "Periodic Current Reversal Electroplating." *Mr. Walter Pinner*, of Houdaille-Hershey Corp., will report on The International Conference on Electrodeposition held in London last fall.

A Tentative Program for the ladies has been planned to include a trip thru "Rochester Radio City" and a Fashion Show at a leading store. The evening program will include Dinner, Dancing, and Entertainment.

Registration should be made with *Mr. James Weaver*, 884 *Whitlock Rd., Rochester 9, N. Y.* A registration fee of three dollars will be made. Tickets for the evening's entertainment and dinner are $3.50.

New York Branch

On Saturday, February 14th, the New York Branch held a testimonial dinner at the home of *Mr. Henry Levine*, inventor of the Levine Bright Nickel plating bath, who has been for 25 years an outstanding member of the association. Various speakers expressed their gratitude to Mr. Levine for the help and assistance which he has always given so generously to those associates who were in distress, and conveyed the wishes of the entire branch for the speedy recovery of their guest of honor.

Boston Branch

The 13th Annual Technical Session and Banquet of the *Boston Branch* of the *A.E.S.* will be held at the Hotel Statler on April 17th. The technical sessions will start a 2:30, and will feature talks by *Senator Richard I. Furbush*, *Mr. Adolph Bregman*, *Mr. R. C. Strawbridge*, and *Mr. L. J. Donroe*. *Mr. Leonard Chesworth* is the Technical Chairman, and *Mr. Manson Glover* is the General Chairman.

Toronto Branch

The Regional Educational Meeting of the *Toronto Branch* of the *A.E.S.* will be held at the General Brock Hotel, Niagara Falls, Ontario, on May 15th. *Mr. E. P. Blandy*, President of the Branch, will act as Chairman. Speakers for the afternoon technical session will be *Mr. H. L. Kellner, Ph.D.*, Director of Research, *Lea Mfg. Co.*, and *Mr. Charles M. Belvin*, of the *Chromium Corp. of America.*

Following this, there will be a banquet, at which time *Mr. Joseph Bliss*, of Oneida Ltd., will talk on "The Romance of Silver". Dancing and miscellaneous entertainment will follow.

Los Angeles Branch

A talk by *Richard J. Wooley*, Los Angeles district manager of *United Chromium, Inc.*, on conversion coatings featured the educational session of the March 10 meeting of Los Angeles Branch, *American Electro-Platers' Society.*

Mr. Wooley presented a review of the history of conversion coatings, including some highly interesting comment on their use during the war, and gave some special emphasis to post-war uses and post-war modifications to provide low cost decorative finishes with high corrosion resistance.

The business session was attended by 72 members and guests. President *Howard Woodward* of the *Sundmark Supply Co.* presided. The following new members were initiated:

Sam Salzman and *Percy H. King* of Allied Record Machine Co.; *E. J. Mooney*, Modern Plating Co.; *Calvin E. Snellgrove*, Pardner Metal Cut Division, California Juvenile Products; *James Barker*, Aircraft Plating Co.; *Richard Dulgarian*, Standard Nickel & Chrome Plating Co.; *Sidney Pinhasik*, Latex Seamless Products Co.; and *Carlyle L. Farmer*, Pacific Airmotive Co.

Reports on sick members disclosed that *Ernie Francis* had recently suffered a severe heart attack; that *Joe Sunderhaus* is in the convalescant stage after a period of hospitalization; and that *Frank Rushton* has improved to such an extent that he announced he would attend the branch's Educational Session at the Breakfast Club on March 20.

Milwaukee Branch

The annual dinner meeting and technical session will be held at the Schroeder Hotel on April 24th. The technical session will be a "Symposium of Post War Finishes," and will feature the following speakers:

1—*Mrs. Gladys Obendorfer*, Training Supervisor, Gimbel Bros.
2—*Mr. Frank Savage*, Vice Pres., Standard Plating Rack Co.
3—*Dr. R. B. Saltonstall*, Tech. Director, Udylite Corp.
4—*Dr. R. H. Schaeffer*, Tech. Director, Cleveland Graphite Bronze Co.

NATIONAL ASS'N OF CORROSION ENGINEERS

Two eminent research authorities, *Dr. Ulick R. Evans* and *Dr. John M. Pearson*, have been named recipients of the 1948 awards of the National Association of Corrosion Engineers. Dr. Evans has been honored with the Willis Rodney Whitney Award in Corrosion Science and Dr. Pearson with the Frank Newman Speller Award in Corrosion Engineering.

International Conference on Surface Reactions

The Pittsburgh International Conference on Surface Reactions will be held at the *Mellon Institute for Industrial Research* in Pittsburgh, June 7-11, 1948.

The Conference Committee is made up of the following: *Dr. Earl Gulbransen* (Westinghouse Research Laboratories) Chairman, representing The Electrochemical Society, Pittsburgh Section; *Prof. D. S. McKinney* (Carnegie Institute of Technology) representing The University Conference on Corrosion and Metal Protection; *Prof. Mars Fontana* (Ohio State University) representing The Electrochemical Society, Corrosion Division; *J. M. Bialosky* (Research Laboratory, Carnegie-Illinois Steel Company) representing The National Association of Corrosion Engineers; *Dr. J. W. Hickman* (Westinghouse Research Laboratories) representing The Pittsburgh Physical Society; *C. Pogocar* (Mellon Institute for Industrial Research) representing The American Society for Metals, Pittsburg Chapter; *Dr. George H. Young* (Mellon Institute for Industrial Research) representing The American Chemical Society, Pittsburgh Section; *Richard Rimbach* (Corrosion Publishing Company) representing The Corrosion Forum.

Preliminary plans call for technical sessions mornings and evenings and visits to Pittsburgh research laboratories, which are working on surface reactions, in the afternoons.

MASTERS' ELECTROPLATING ASS'N

The monthly report of the *Masters' Electroplating Association* indicates that the rate of job shop operations, while slightly higher than in January, is much lower than at the beginning of last year. Operators report that new business is decreasing, and only one shop out of 70 is working extra shifts. An increase in supply prices has also cut into profits, as prices for plated work have remained substantially the same for some time.

Obituary

George Gehling Passes Away

We announce with deepest regret the passing of Mr. George Gehling, of the Frederick Gumm Chemical Co., on Jan. 26th, after a long illness. Mr. Gehling was well known in the finishing field, having been a past President of the American Electroplaters Society in 1930. Prior to that he had been Vice-President for four years, and was at all times very active in the affairs of the Society, of which he was an Honorary Member.

Mr. Gehling is survived by his widow, five children, and sixteen grandchildren.

News from California

By Fred A. Herr

American Factors, Ltd., Honolulu, has been appointed by *Victor Chemical Co. of Cal.,* as exclusive distributor for Victor products in the Hawaiian Islands and the entire Pacific Southwest, according to *D. H. Jackson,* president.

Victor's research engineer, *Walter J Hyatt,* has just returned from a trip to the Islands where, working in cooperation with American Factors, Ltd., he introduced some 45 Victor chemical compounds to industrial users in the Hawaiian Islands and other parts of the Pacific area.

The company's products are principally for the industrial, marine and aviation industries and include desealants, paint strippers, aircraft surface brighteners and emulsifying cleaners.

Kelite Products, Inc., Los Angeles, has announced the promotion of *Clarence Coleman* to regional manager of the firm's Arizona-Nevada district, with headquarters in Phoenix, Ariz. He joined the Kelite organization in 1943. For the past four years he had been Kelite's Southern Arizona-Western New Mexico representative.

Ray Sanders has been appointed general manager of the *Pacific Chemical Co., Los Angeles,* a division of *American Marietta Co.* He was formerly active in the automotive and industrial cleaning field for some 25 years.

Robert L. Waldeck, manager of export sales for *Turco Products, Inc.,* has returned from a 2½ months trip during which he visited Turco sales agents in a dozen or more Latin American countries to introduce to them the latest additions to the firm's line of industrial chemical compounds. Waldeck visited Cuba, Porto Rico, Brazil, Venezuela, Uraguay, Argentina, and a half dozen other South American countries.

READY-REFERENCE SECTION
—USED EQUIPMENT AND SUPPLIES—